

# ***Knoxville Regional Travel Model Update 2012***

## **Socioeconomic Control Total Projections Report**

Prepared for the  
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## **Introduction and Executive Summary**

The success of traffic forecasting, and more broadly, transportation planning, depends in no small part on the reasonableness and credibility of the socioeconomic forecasts on which it is based. Moreover, the reality of demographic and economic forecasting is that judgments must be made. Most mass producers of projections simplify this process by making the exact same judgments for all of the areas they are forecasting. For example, they may make the assumption that fertility rates in all counties will eventually converge with nationally projected rates; whereas, in reality there may be numerous counties where there is no historical evidence of convergence and there likely never will be. Superior forecasts can be derived by recognizing specific local historical conditions and incorporating them into the forecasting assumptions.

Out of recognition of these facts, as a part of BLA's contract with the Knoxville TPO to update its regional travel model to a new 2010 base year, BLA was also tasked with developing local socioeconomic control total forecasts. These control totals will assist the TPO in developing future land use scenarios for use with the travel model for traffic forecasting and for more general planning for the Eastern Tennessee region.

The forecasts include interrelated county control totals for population, employment (by the model's four sectors), labor force (or workers), seniors and school-aged children. Control totals were developed separately for each of the ten counties in the model area: Anderson, Blount, Grainger, Hamblen, Jefferson, Knox, Loudon, Roane, Sevier and Loudon counties.

Since the level of traffic growth predicted by Knoxville's travel model, as with most travel models, is driven primarily by population growth and secondarily the number of workers, the focus of the forecasting effort was invested in applying the labor force linkage cohort survival methodology. This method takes advantage of the good annual and quarterly time series labor force data available at the county level to forecast levels of in- and out-migration to supplement basic cohort survival techniques. It provides inter-related and consistent forecasts of population, workers, senior and student-aged populations.

Employment, which determines more the location of traffic than its overall intensity in the context of travel models, is forecast separately, using a simpler approach based on the examination and extrapolation of historical growth rates and patterns. The comparison between the number of workers and employment provides an estimate of unemployment which serves as an independent reasonableness check on the consistency of the employment forecasts with the labor force and population forecasts.

The population and employment growth from the recommended forecasts are presented below in Figure 1 through Figure 3.

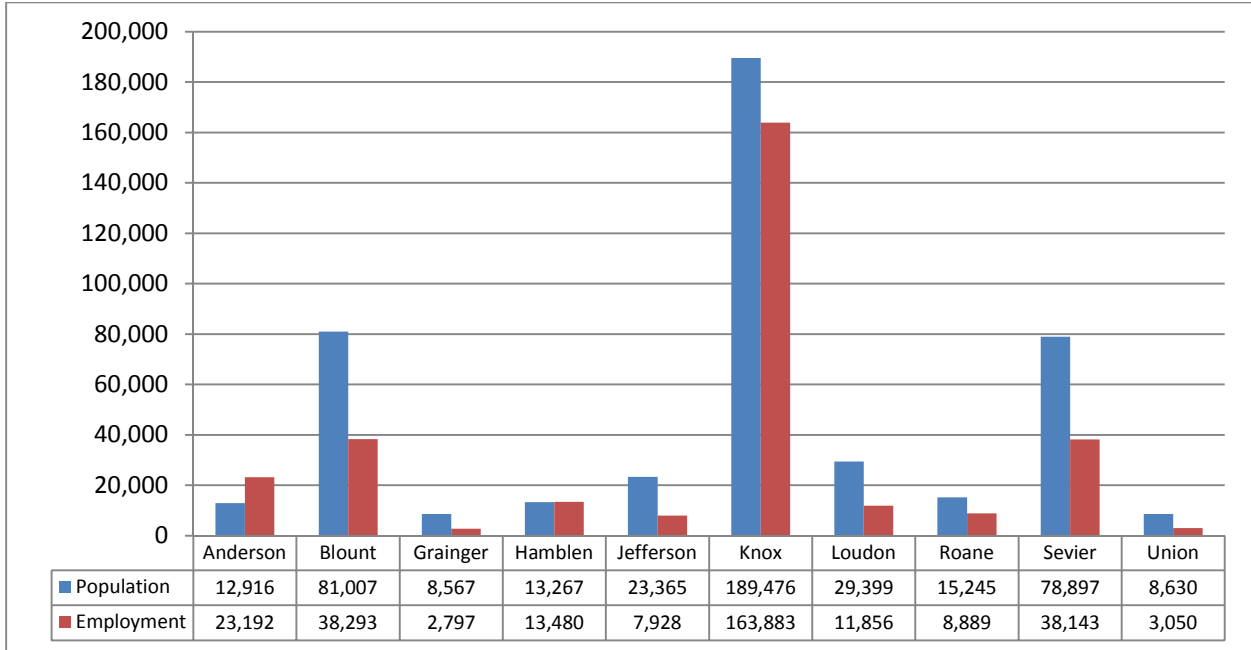


Figure 1 Projected Absolute Growth, 2010-2040

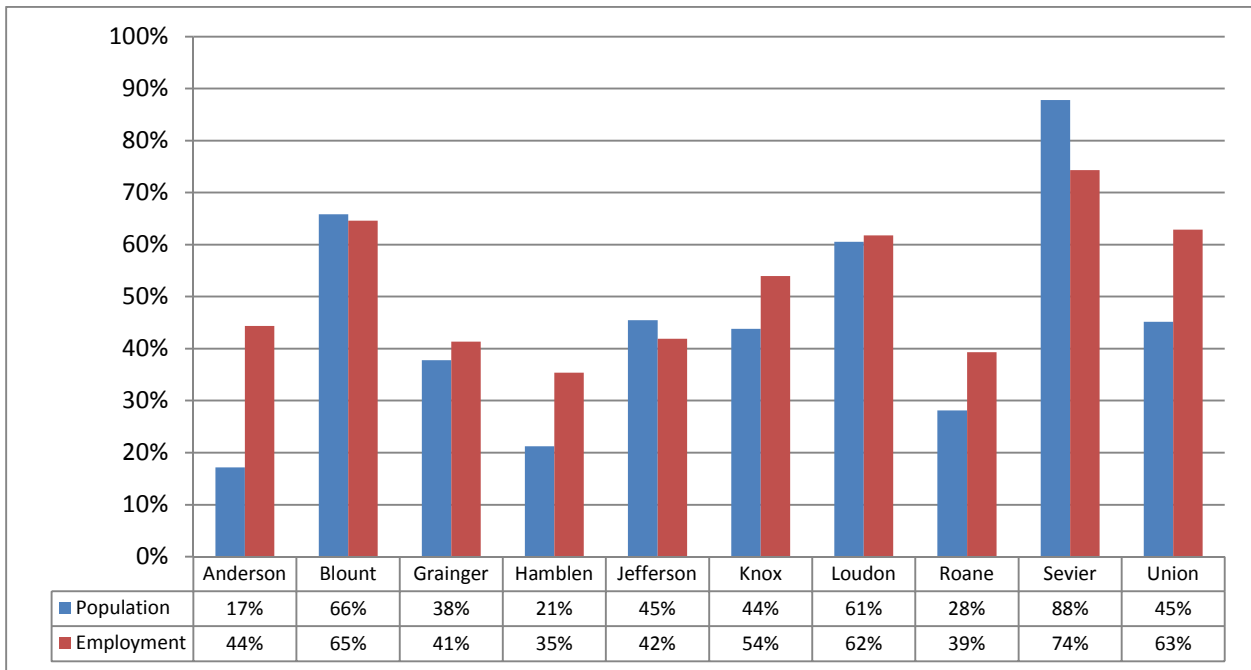
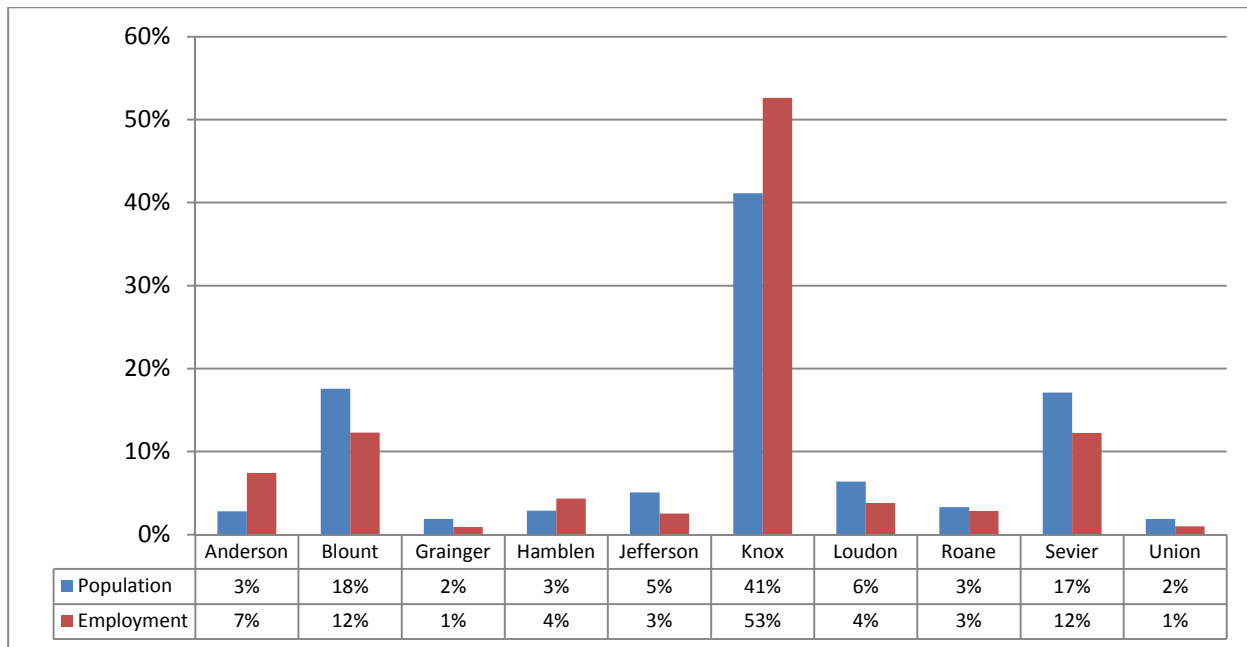


Figure 2 Projected Percent Increase, 2010-2040



**Figure 3 Share of Regional Growth by County**

As expected, the forecasts show Knox County accounting for roughly half the regional growth, followed by Blount and Sevier counties with between 10 and 20% of the regional growth a piece. Knox and Anderson show stronger employment than population growth, continuing their traditional roles as job centers for the region, while population growth outpaces employment as Blount County continues to develop as a bedroom community for Knoxville and Sevier continues to attract retirees and part time residents.

The subsequent documentation presents the forecasts in detail together with the methodology employed to develop them.

### Labor Force Linkage Cohort Survival

The labor force linkage cohort survival method of demographic forecasting relies on the decomposition of population change into three components: births, deaths and migration. Most responsible methods of population forecasting begin with these three components of change. Independent projections of each component are made and then the “bottom line” is computed using the following simple equation:

$$Projected\ Population = Previous\ Population + [(Births - Deaths) + Net\ Migration]$$

Although each of the three components of population change are subject to their own sources of uncertainty, detailed historical fertility and mortality rates by county are maintained by the Tennessee Department of Health, Office of Policy, Planning and Assessment, Division of Health Statistics and provide a good basis for forecasting future births and deaths. By far the most

unpredictable component of population change at the local level is net migration. The most common method of projecting this variable has been to utilize recent historical net migration rates and assume that they will continue to apply throughout the foreseeable future. Alternatively, some forecasters make the assumption that these rates will converge with a “net zero rate” over time. Invariably, neither of these assumptions hold true because of the erratic nature of net migration flows. For example, an area may become popular due to its low cost of new housing and low property tax rate. This may result in net in-migration for a few years. Following this period, a major employer may come on bad economic times laying off or moving a large number of its employees. Consequently, the historical pattern of in-migration then changes to severe net out-migration. A few years later, a major new employer comes into the area and the trend reverses itself again to a flow of in-migrants.

Due to the importance of these volatile net-migration rates, some demographers have modified the traditional “cohort survival method” of forecasting local area population and moved toward methods that relate future population to expected labor force and labor force participation rates. Indigenous labor force is a much easier variable to project than migration rates in large part because it has been estimated quarterly and annually at the county level for many years by the U.S. Department of Labor, Bureau of Labor Statistics using consistent estimation methods based on legally required tax forms, as opposed to migration which is only reliably observed once every ten years from the decennial Census. The labor force linkage cohort survival method therefore generates net migration as an output or by-product of the population projection, based on labor force forecasts, rather than requiring it as an input.

### **Fertility Rates**

Historic birth rates by age cohorts for women aged 10 to 45 were obtained for each county from the Tennessee Department of Health, Office of Policy, Planning and Assessment, Division of Health Statistics for the years 2005-2010 (see Table 1).

**Table 1 Birth Rates by Age Cohort by County**

	<b>Anderson</b>	<b>Blount</b>	<b>Grainger</b>	<b>Hamblen</b>	<b>Jefferson</b>	<b>Knox</b>	<b>Loudon</b>	<b>Roane</b>	<b>Sevier</b>	<b>Union</b>
10 to 14	0.18	0.44	1.20	0.40	0.26	0.52	0.64	0.62	0.64	0.98
15 to 19	47.94	43.29	57.68	75.18	45.75	34.44	59.15	60.03	60.57	58.10
20 to 24	131.00	103.72	142.68	168.60	108.02	77.60	136.10	124.38	144.65	138.40
25 to 29	92.68	86.60	80.63	96.95	77.72	100.92	101.97	78.90	91.97	80.25
30 to 34	92.68	86.60	80.63	96.95	77.72	100.92	101.97	78.90	91.97	80.25
35 to 39	39.10	15.95	10.97	15.10	15.67	22.35	16.90	12.55	17.58	9.87
40 to 44	39.10	15.95	10.97	15.10	15.67	22.35	16.90	12.55	17.58	9.87

The observed rates were meaningfully different by county. For instance, the presence of the University of Tennessee student population correlates with lower fertility rates for women aged 15 to 24 in Knox County. Similarly, the Knox County rates evidence deferred fertility with higher

rates in the late twenties and early thirties as is becoming common in larger urban areas; whereas, more rural areas have more traditional patterns with higher birth rates in the early twenties.

The pattern over the period from 2005 to 2010 was less consistent. In most of the age cohorts, in most of the counties, fertility rates decreased in the last few years. However, the pattern was still fairly inconsistent, and to the extent that it is thought to be driven by the economic recession, may be thought to be more of a temporary effect than a long term trend. For that reason, the six year average fertility rates over the period from 2005-2010 were used for each county.

### **Mortality Rates**

Historic mortality rates by age cohorts by age cohort and gender were obtained for each of the ten counties from the Tennessee Department of Health, Office of Policy, Planning and Assessment, Division of Health Statistics for the years 1990-2010.

In contrast to the birth rates which appeared to vary significantly across the counties, but not particularly meaningfully over time, the mortality rates clearly varied more significantly over time than geography. Although there was some variation in mortality rates by county, there was not enough data to reliably forecast mortality rates (by age and gender) over time for each county separately. The data for the counties was therefore combined and a set of mortality rates by age and gender was forecast over time for the region as a whole. It is important to forecast mortality rates over time rather than rely on historic average rates because mortality rates have been consistently decreasing as life expectancies have increased for more than a century.



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**Table 2 Historic and Projected Mortality Rates by Age Cohort and Gender**

<b>Males</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>
Under 5	218.97	160.33	171.23	175.73	168.19	157.27	150.52	143.77	137.02	130.27
5 to 9	24.99	19.05	17.04	16.22	15.87	14.90	13.67	12.45	11.22	9.99
10 to 14	28.28	16.02	21.07	16.38	16.87	16.86	15.87	14.87	13.88	12.89
15 to 19	108.05	118.89	116.18	93.48	97.04	99.22	96.46	93.71	90.95	88.19
20 to 24	153.05	141.00	169.38	157.66	157.84	158.46	159.34	160.23	161.11	162.00
25 to 29	179.24	140.41	171.95	166.53	165.76	165.07	165.22	165.37	165.52	165.67
30 to 34	203.68	197.09	192.72	185.58	184.56	181.73	178.11	174.49	170.87	167.25
35 to 39	265.29	292.04	267.54	242.01	244.85	244.62	238.49	232.35	226.21	220.07
40 to 44	345.11	334.70	408.58	350.58	370.63	395.66	405.64	415.62	425.60	435.58
45 to 49	491.75	442.21	542.50	561.72	558.11	561.74	576.24	590.74	605.24	619.74
50 to 54	782.56	721.92	756.62	857.67	857.67	857.67	857.67	857.67	857.67	857.67
55 to 59	1274.5	1208.7	1090.3	1089.0	1054.0	995.30	947.99	900.68	853.37	806.06
60 to 64	1975.3	1689.0	1653.6	1594.9	1487.3	1323.5	1211.1	1098.6	986.20	873.78
65 to 69	2984.7	2694.1	2607.2	2254.4	2206.9	2082.9	1929.5	1776.1	1622.7	1469.3
70 to 74	4526.4	4339.8	3717.7	3456.8	3337.6	3090.6	2835.2	2579.8	2324.4	2068.9
75 to 79	7058.4	6545.9	6137.6	5526.7	5406.2	5119.4	4786.6	4453.9	4121.2	3788.5
80 to 84	10481	10141	9727.1	9011.9	8699.4	8152.5	7683.6	7214.8	6745.9	6277.2
85 & up	17704	18140	17503	16269	16107	15709	15238	14767	14296	13825
<b>Females</b>	<b>1995</b>	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>
Under 5	150.65	124.70	125.38	121.90	117.48	110.22	104.54	98.87	93.19	87.51
5 to 9	17.63	22.70	18.17	11.16	12.77	13.88	12.90	11.92	10.94	9.96
10 to 14	20.21	24.01	17.44	15.68	15.74	15.24	14.10	12.97	11.83	10.69
15 to 19	42.14	40.84	43.47	33.06	35.01	36.49	35.55	34.61	33.67	32.73
20 to 24	48.19	52.37	59.56	66.88	66.48	67.57	70.58	73.59	76.59	79.60
25 to 29	73.63	56.08	61.24	93.13	86.63	81.59	84.53	87.47	90.40	93.34
30 to 34	76.83	79.42	86.87	96.68	96.10	97.23	100.64	104.05	107.46	110.87
35 to 39	121.89	125.54	159.60	145.64	150.92	159.12	164.94	170.76	176.58	182.40
40 to 44	155.20	183.78	227.45	251.11	255.21	268.16	285.88	303.59	321.31	339.02
45 to 49	259.70	264.85	301.91	344.77	342.44	347.75	363.01	378.27	393.54	408.80
50 to 54	411.18	385.92	465.40	458.80	460.42	467.14	477.37	487.60	497.83	508.05
55 to 59	665.18	644.81	713.73	668.59	676.20	685.55	689.02	692.49	695.95	699.42
60 to 64	1097.0	1099.0	1075.7	980.59	965.28	931.73	895.24	858.75	822.25	785.76
65 to 69	1628.2	1582.1	1541.1	1541.4	1503.6	1448.4	1413.7	1379.1	1344.4	1309.7
70 to 74	2488.1	2563.8	2527.1	2266.7	2252.4	2202.1	2130.0	2057.9	1985.9	1913.8
75 to 79	3881.6	4073.9	4038.8	3589.5	3598.6	3561.1	3468.0	3375.0	3281.9	3188.9
80 to 84	6547.6	6662.1	6946.0	6008.0	6098.5	6132.3	6018.8	5905.3	5791.8	5678.3
85 & up	14199	15129	14973	12808	12934	12864	12471	12078	11686	11293

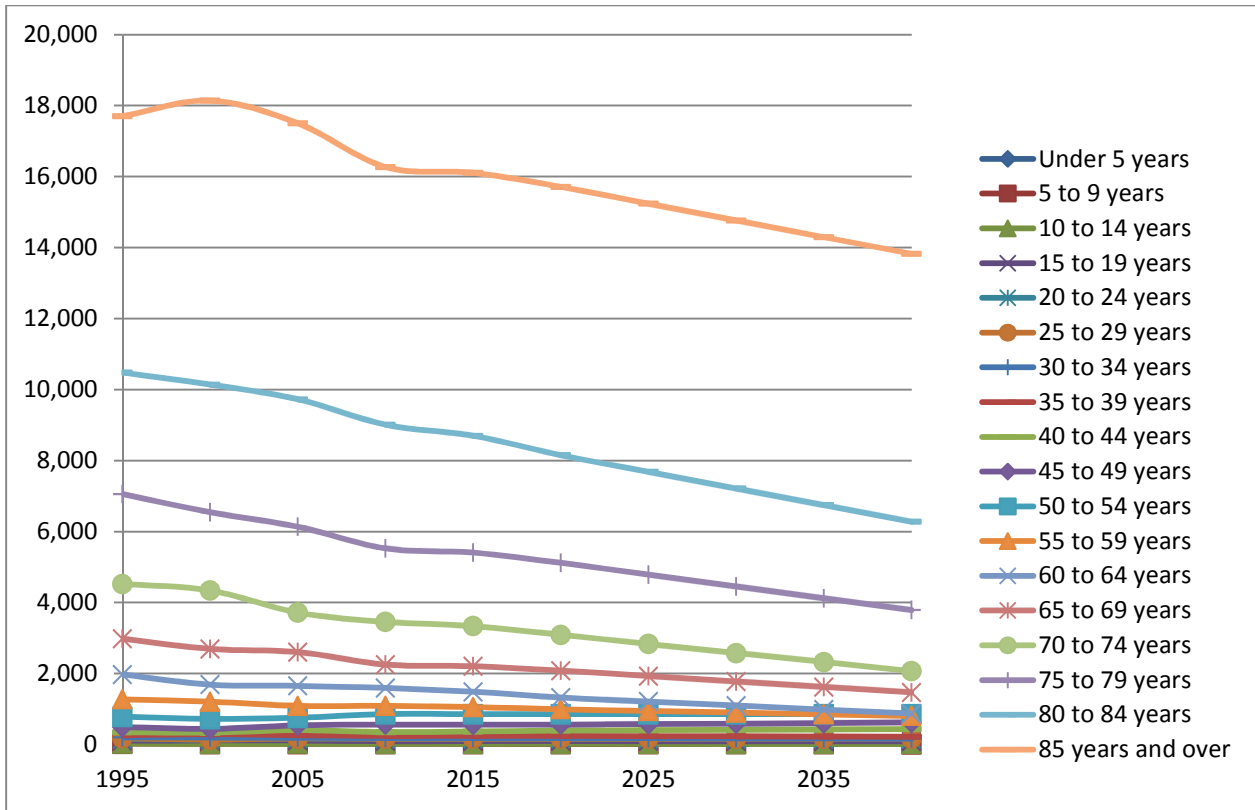


Figure 4 Eastern Tennessee Mortality Rates per 100,000 Males, 1995-2040

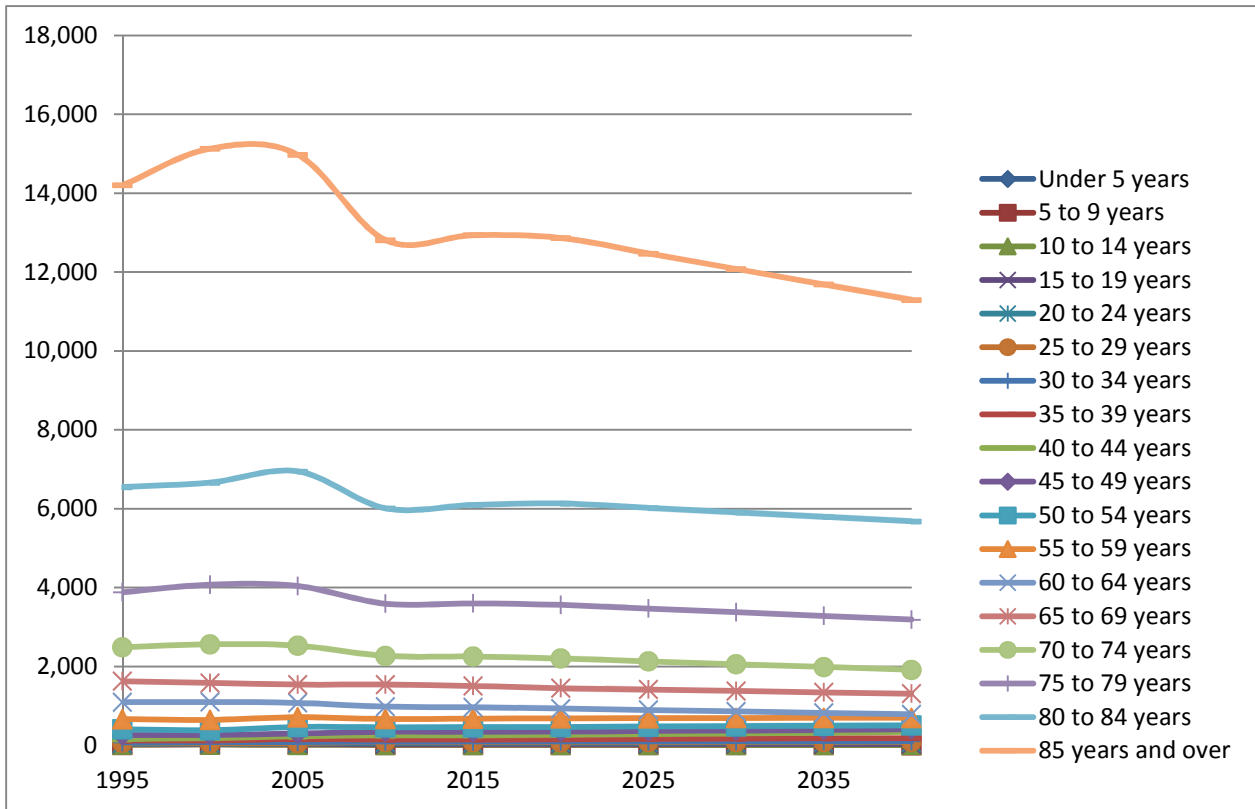


Figure 5 Eastern Tennessee Mortality Rates per 100,000 Females, 1995-2040

In forecasting mortality rates, BLA generally relied on linear extrapolation of the trends over the past twenty years, but with a few exceptions where dampening was applied to ensure that each male mortality rates remained greater or equal to female mortality rates for the same age cohort and that each successive age cohort's rates are higher than the next younger cohort. Neither Woods & Poole nor UT's Center for Business and Economic Research publish their mortality forecasting methodology, but differences in forecast longevity/mortality rates appears to be one of the differences between the population forecasts.

## **Labor Force**

The U.S. Department of Labor, Bureau of Labor Statistics, provides monthly labor force data based on required payroll tax reporting, unemployment claims, etc. Historic labor force data was obtained for the ten counties for the twenty year period from 1990-2010.

This data was used to make multiple forecasts based on linear regression over the whole and/or a subset of the data, non-linear regression, the twenty year average growth rate, and the highest and lowest ten year growth rates observed within the past twenty years. The forecasts produced by these various methods were then compared and professional judgment used to select the best forecast. In some cases, the chosen forecast was a compromise or weighted average between two or more of the basic forecasts.

**Table 3 Historic and Projected Labor Force by County**

	<b>Anderson</b>	<b>Blount</b>	<b>Grainger</b>	<b>Hamblen</b>	<b>Jefferson</b>	<b>Knox</b>	<b>Loudon</b>	<b>Roane</b>	<b>Sevier</b>	<b>Union</b>	<b>Region</b>
1990	32,915	41,803	8,018	25,944	16,582	173,808	15,981	21,831	27,257	6,317	372,446
1995	36,151	49,948	9,715	30,455	21,599	196,793	19,127	28,911	33,501	7,373	435,568
2000	34,058	54,348	9,760	29,758	22,593	202,414	19,614	24,900	39,837	8,128	447,410
2005	34,933	59,769	10,171	29,782	23,809	216,490	21,930	25,918	45,540	8,830	479,177
2010	36,211	63,591	10,059	29,586	24,332	232,390	23,640	27,738	49,191	8,888	507,636
2015	37,140	68,884	10,635	30,370	25,860	249,792	25,870	29,122	56,300	9,669	545,658
2020	38,069	74,178	11,211	31,154	27,388	267,195	28,100	30,506	63,408	10,450	583,679
2025	38,998	79,471	11,786	31,938	28,917	284,597	30,331	31,890	70,517	11,232	621,701
2030	39,926	84,765	12,362	32,722	30,445	302,000	32,561	33,274	77,626	12,013	659,723
2035	40,855	90,058	12,938	33,506	31,973	319,402	34,791	34,658	84,734	12,794	697,745
2040	41,784	95,351	13,514	34,290	33,501	336,804	37,021	36,042	91,843	13,575	735,766

Summarized historic and viable and chosen projections of labor force for each county are found in Appendix A. The resulting projections are displayed together with the historic data for in five year increments in Table 3. The projected regional total labor force resulting from the chosen county forecasts was also plotted against simple historic rate based forecasts as an independent reasonableness check (displayed in Figure 6).

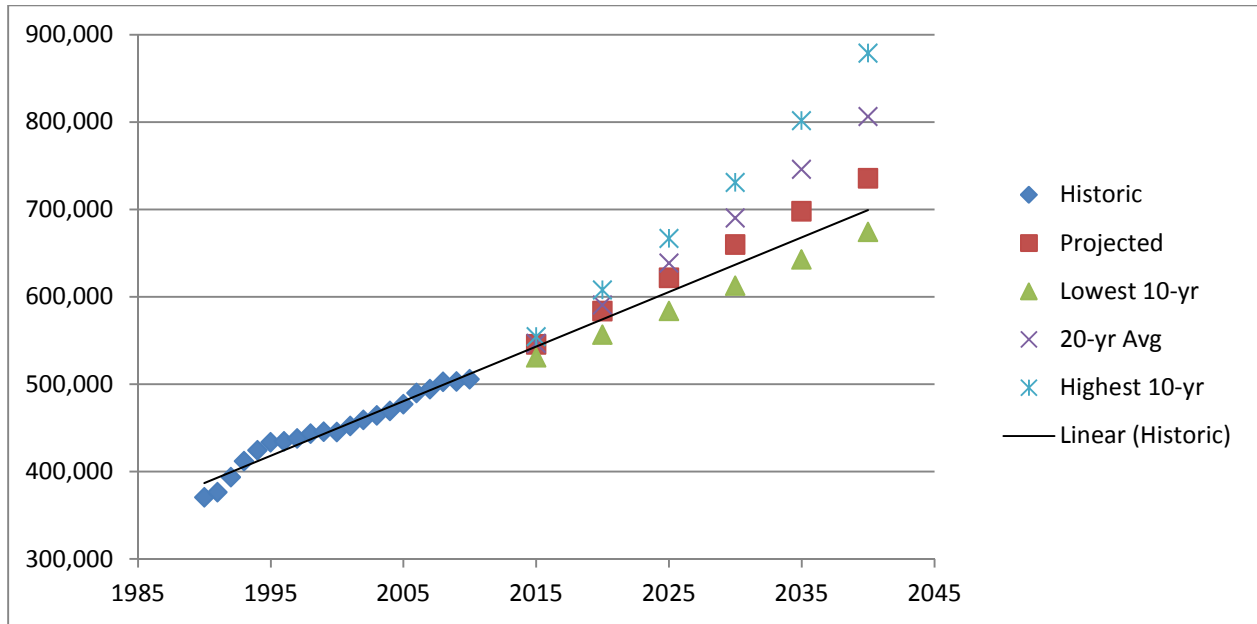


Figure 6 Eastern Tennessee Regional Labor Force, 1990-2040

Labor force is very closely related to the household workers variable in the travel model, although there are some subtle differences. The differences are that labor force includes unemployed adults actively seeking work and does not include self-employed workers who are ineligible for unemployment insurance; whereas, the household workers in the model do not include the unemployed but do include the self-employed. Because of these definitional differences, the labor force forecasts should not be used directly as a forecast of household workers. However, because of the closeness of the definitions the relative growth in labor force, presented in Table 4, can validly be applied to the number of household workers to produce future year county control totals for the number of household workers.

Table 4 Future Growth in Labor Force/Household Workers Relative to 2010

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
2015	2.57%	8.32%	5.72%	2.65%	6.28%	7.49%	9.43%	4.99%	14.45%	8.79%
2020	5.13%	16.65%	11.45%	5.30%	12.56%	14.98%	18.87%	9.98%	28.90%	17.58%
2025	7.70%	24.97%	17.17%	7.95%	18.84%	22.47%	28.30%	14.97%	43.35%	26.37%
2030	10.26%	33.30%	22.90%	10.60%	25.12%	29.95%	37.74%	19.96%	57.80%	35.16%
2035	12.83%	41.62%	28.62%	13.25%	31.40%	37.44%	47.17%	24.95%	72.26%	43.95%
2040	15.39%	49.94%	34.34%	15.90%	37.68%	44.93%	56.60%	29.94%	86.71%	52.73%

Two additional variables are required to convert the labor force projections into net migration and population projections. Those variables are the labor force participation rate and the dependency ratio. The labor force participation rate is the ratio of the labor force to the total population over 15. The dependency ratio is the ratio of population 15 and under to the population over 15. The labor force linkage cohort survival method of population forecasting then makes use of the following equation:

$$\text{Total Population} = \frac{(\text{Labor Force} \div \text{Labor Force Participation Rate})}{\text{Dependency Ratio}}$$

This equation is used to calculate the total population (and the population over and under 15) and the difference between these values and those produced by simple cohort survival resulting from applying birth and mortality rates is the net migration.

### **Labor Force Participation Rates**

Historic labor force participation rates were calculated for each county from the BLS labor force estimates and Census populations for 1990, 2000 and 2010. Historically, labor force participation rates have risen since the mid-twentieth century as women have entered the labor force until the early part of the previous decade, by which time women's participation in the labor force was nearly approaching men's and the aging of the baby boomer generation became the salient factor driving labor force dynamics, together with the trend towards more time spent in education. However, because these dynamics play out at different paces in different local areas, mitigated by a variety of other factors acting in particular counties, labor force participation rates are perhaps the most difficult variable to predict in the labor force linkage cohort survival method. The national labor force participation rate peaked nearly ten years ago and has since been declining. However, looking at the ten eastern Tennessee counties in the Knoxville model area, various patterns are observed. Some counties peaked in 2000 as the nation did as a whole, while some (particularly those with larger senior populations) were already declining by 2000 and others had not peaked yet. The ten county region as a whole, however, did roughly mirror the nation, peaking somewhere near 2000, but lagging the nation somewhat in that by 2010 the national rate had fallen below its 1990 level, whereas, the regional rate had fallen below its 2000 level but not to its 1990 level.

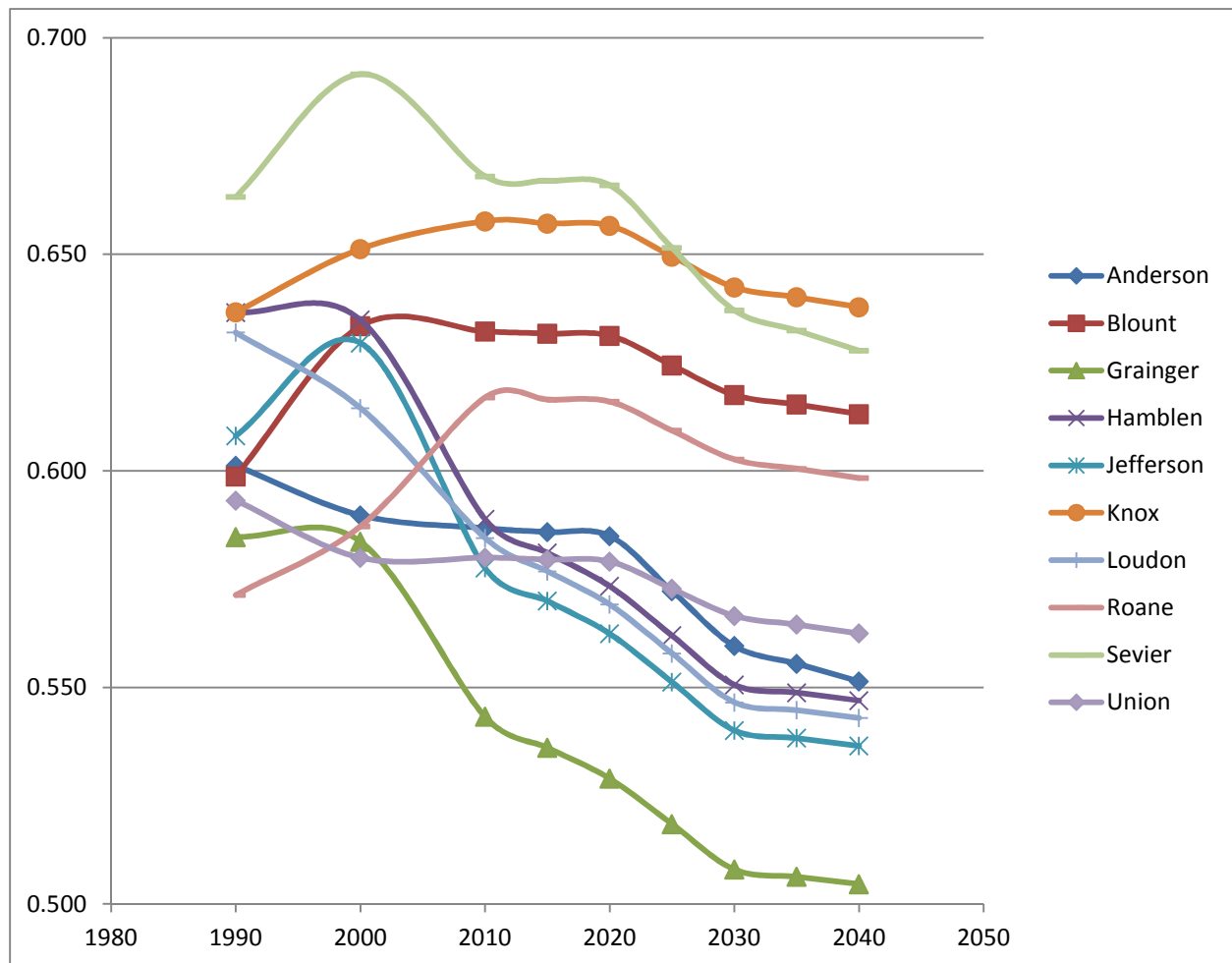
Four published forecasts of national labor force participation rates were used to develop forecasts of local labor force participation. Two were official forecasts by U.S. government agencies (Bureau of Labor Statistics, Congressional Budget Office) and two were widely cited academic publications (Toosi, 2006 and Szafran, 2002) which have been partially validated over recent years. All four provided estimates of labor force participation in 2020 (0.645, 0.632, 0.645 and 0.630). The two academic sources provided forecasts out to 2040 (0.608 and 0.601, respectively). For counties with historic patterns that mirrored (or lead) national trends, forecasts were developed by simply pivoting off of national forecasts. For counties with historic patterns that lagged or possibly ran counter to national trends, forecasts were developed as a compromise or weighted average between national forecasts and local historic trends. Some consideration was also given to the in-migration of retirees in some counties and the effects of the University of Tennessee constantly supplying young workers in Knox County. In all cases, rates were forecast to decrease by 2040, but for counties that had not shown any sign of

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decrease yet, rates were allowed to approximately hold steady out through 2020 before beginning to decline and the final rates in these counties had sometimes not yet dropped to 1990 levels even by 2040. Table 5 and Figure 7 shows the historic and projected labor force participation rates by county.

**Table 5 Historic and Projected Labor Force Participation Rates by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union	Region	Nation
1990	0.601	0.599	0.585	0.637	0.608	0.637	0.632	0.571	0.663	0.593	0.624	0.665
2000	0.590	0.633	0.584	0.635	0.630	0.651	0.615	0.587	0.692	0.580	0.637	0.671
2010	0.587	0.632	0.543	0.589	0.578	0.658	0.585	0.617	0.668	0.580	0.631	0.647
2015	0.586	0.632	0.536	0.581	0.570	0.657	0.577	0.616	0.667	0.580	0.629	0.642
2020	0.585	0.631	0.529	0.573	0.562	0.657	0.569	0.616	0.666	0.579	0.627	0.638
2025	0.572	0.624	0.518	0.562	0.551	0.649	0.558	0.609	0.652	0.573	0.619	0.624
2030	0.560	0.618	0.508	0.551	0.540	0.642	0.547	0.603	0.637	0.567	0.610	0.611
2035	0.555	0.615	0.506	0.549	0.538	0.640	0.545	0.600	0.632	0.565	0.607	0.608
2040	0.551	0.613	0.505	0.547	0.537	0.638	0.543	0.598	0.628	0.562	0.605	0.605



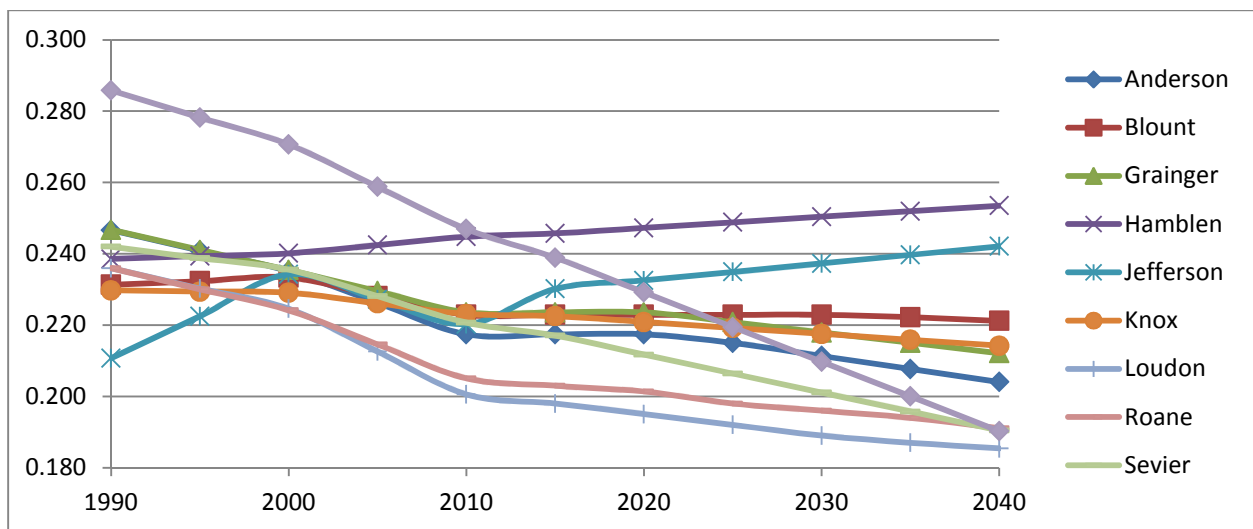
**Figure 7 Labor Force Participation Rate by County, 1990-2040**

**Dependency Ratios**

Historic dependency ratios from the 1990, 2000 and 2010 Censuses were obtained for each county. Dependency ratios have been generally been falling across the country since the introduction of artificial contraception as people have chosen to have fewer children. For this reason, in contrast to labor force participation, dependency ratios are typically more easy to project. The national trend is generally observed throughout the eastern Tennessee region, with the exceptions of Hamblen and Jefferson counties. Given the generally clear and consistent local trends observed, future dependency ratios were generally simply linearly extrapolated, although trends were dampened in some counties such as Loudon and Roane to avoid predicting extremely low ratios. Historic and projected dependency ratios are presented in Table 6 and Figure 8.

**Table 6 Historic and Projected Dependency Ratios by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
1990	0.247	0.231	0.247	0.239	0.211	0.230	0.236	0.236	0.242	0.286
1995	0.241	0.232	0.241	0.239	0.222	0.229	0.230	0.230	0.239	0.278
2000	0.235	0.233	0.235	0.240	0.234	0.229	0.225	0.224	0.236	0.271
2005	0.226	0.228	0.230	0.242	0.227	0.226	0.213	0.215	0.228	0.259
2010	0.217	0.223	0.224	0.245	0.220	0.223	0.201	0.205	0.221	0.247
2015	0.217	0.223	0.224	0.246	0.230	0.223	0.198	0.203	0.217	0.239
2020	0.217	0.223	0.224	0.247	0.233	0.221	0.195	0.201	0.212	0.229
2025	0.215	0.223	0.221	0.249	0.235	0.219	0.192	0.198	0.206	0.219
2030	0.211	0.223	0.218	0.250	0.237	0.218	0.189	0.196	0.201	0.210
2035	0.208	0.222	0.215	0.252	0.240	0.216	0.187	0.194	0.196	0.200
2040	0.204	0.221	0.212	0.253	0.242	0.214	0.185	0.191	0.190	0.190



**Figure 8 Dependency Ratios by County, 1990-2040**

## **Calibration**

The foregoing variables were used to apply the labor force linkage cohort survival method of population forecasting for the ten county eastern Tennessee region. Adjustments are necessary to account for large institutional populations. The chief of these in this region being the University of Tennessee student population. These adjustments and other small adjustments to the variables involved (such as any differences in the dependency ratio and age distributions of migrants from current residences, the precise proportion of males to females at birth, etc.) were calibrated to the historic period from 1990 to 2000. For historic years, the model is constrained to reproduce the county total population exactly, but errors can occur and be observed by gender and age cohort. Calculating statistics on these errors by gender and age cohort over all ten counties against the 2000 Census, the root mean square error (RMSE) was 18.7% and the mean absolute percent error (MAPE) was 10.7%, indicating a very good fit overall. The calibrated model was then validated by forecasting from 2000 to 2010. As is generally expected, the error statistics calculated against the 2010 Census were slightly higher than for the 2000 Census since the model was not calibrated specifically for this period. However, the model still performed quite well with a 22.8% RMSE and 15.6% MAPE in 2010. The degradation between 2000 and 2010 appears to be related to the changes over time in the UT student population and their tendency (by gender) to remain in the area after graduation. On the basis of the observed 20 year period alone, it was not possible to forecast these trends with any confidence, so the model was used for forecasting as calibrated. With the small observed errors, a reasonable level of confidence can be had in the model overall.

## **Population Projections**

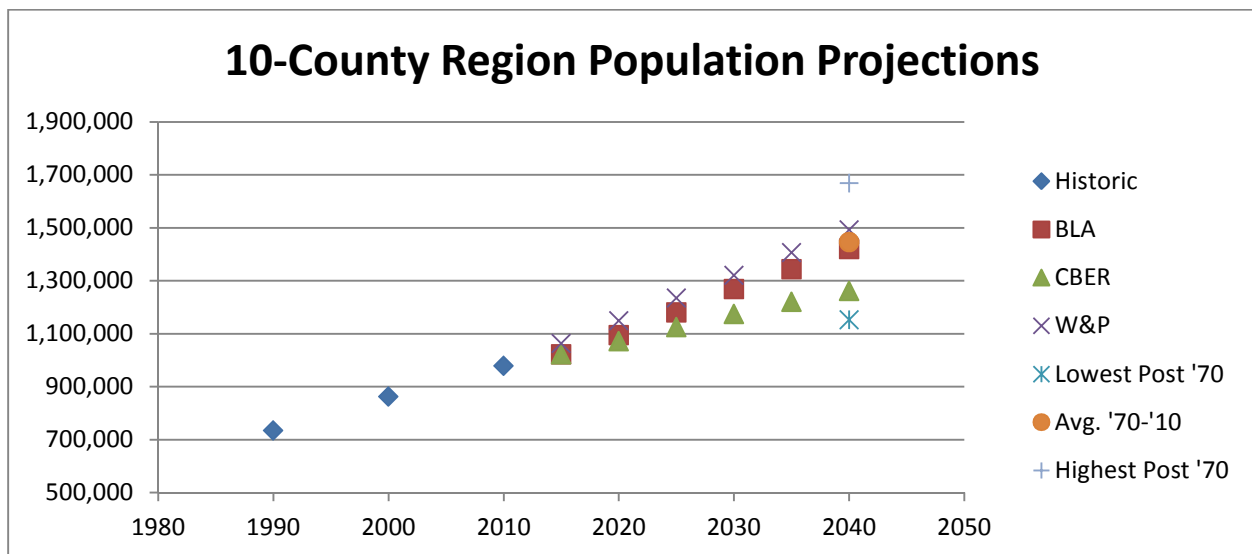
The application of the labor force linkage cohort survival method described above produced population projections for the ten eastern Tennessee counties which generally tended to be somewhat higher than those by UT's Center for Business and Economic Research (CBER) but just slightly lower than those produced by Woods & Poole (W&P) and slightly lower than the average growth over the period from 1970 to 2010. Table 7 presents the historic and projected population by county to 2040 and Figure 9 displays the projected trend for the region as a whole. Detailed graphs comparing each individual county's forecast with historic rates and forecasts from CBER and W&P are presented in Appendix B.

It is important to note that BLA's original forecast for Blount County was revised downward to be more consistent with the county's own population forecasts. The forecasts for Blount County shown here are generally consistent with, but not exactly the same as, the county's forecasts.



**Table 7 Historic and Projected Total Population by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union	Region
1970	60,563	63,822	14,080	39,064	25,134	277,927	24,328	39,058	28,562	9,221	581,759
1980	67,498	77,992	16,782	49,500	31,435	320,932	28,730	48,519	41,725	11,774	694,887
1990	68,250	85,969	17,095	50,480	33,016	335,749	31,255	47,227	51,043	13,694	733,778
2000	71,326	105,823	20,659	58,128	44,294	382,032	39,087	51,910	71,170	17,808	862,237
2010	75,129	123,010	22,657	62,544	51,407	432,226	48,556	54,181	89,889	19,109	978,708
2020	76,609	139,297	24,987	65,487	57,962	482,122	56,997	57,626	112,010	21,442	1,094,539
2030	83,449	162,594	28,517	71,704	67,257	555,118	68,332	63,916	141,899	24,777	1,267,562
2040	88,045	183,913	31,224	75,811	74,772	621,702	77,955	69,426	168,786	27,739	1,419,372



**Figure 9 Eastern Tennessee 10 County Region Population Projections**

**Student-Age and Senior Populations**

The Knoxville regional travel model includes the number of students (per household) and the percentage of households with seniors present as variables for predicting travel patterns. Although it does not forecast these exact variables, the labor force linkage cohort survival method does project two closely related variables that can be used to estimate the future growth in these variables at the county level. The demographic projections include the number of persons in each five-year age cohort. The number of students can be approximated by the student age population taken as the 5-9, 10-14 and 60% of the 15-19 year old cohorts. The growth in these cohorts can be taken as the growth in students and applied to the 2010 base year students to produce future year country control totals. The historic and projected student aged population by county is presented in Table 8 and the growth in student-aged population (or students) is presented in Table 9. For some counties, some of the interim year projections were smoothed to avoid some unrealistic oscillation which can occur as a result of the nature of the method.

## **Knoxville Regional Travel Model Update 2012**

**Table 8 Historic and Projected Student Aged Population by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
1990	12,078	14,507	3,147	9,011	5,725	56,254	5,334	8,460	9,063	2,707
2000	12,371	18,040	3,463	9,719	7,590	64,016	6,200	8,439	12,038	3,358
2010	12,119	20,360	3,665	10,630	8,601	70,251	7,201	8,485	14,483	3,257
2015	11,388	21,568	3,805	10,410	8,963	74,895	8,199	7,688	15,349	2,817
2020	11,724	22,777	3,945	11,237	9,325	79,538	9,198	8,160	15,824	3,056
2025	12,352	23,985	4,085	11,611	9,687	84,181	10,197	8,631	18,474	3,295
2030	13,133	25,194	4,225	12,011	10,049	88,824	11,195	9,103	22,013	3,534
2035	13,756	26,403	4,365	12,428	10,411	93,468	12,063	9,574	25,481	3,773
2040	14,489	27,611	4,504	13,332	10,773	98,111	12,931	10,046	28,001	4,012

**Table 9 Future Growth in Student Aged Population versus 2010**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
2015	-6.0%	5.9%	3.8%	-2.1%	4.2%	6.6%	13.9%	-9.4%	6.0%	-13.5%
2020	-3.3%	11.9%	7.6%	5.7%	8.4%	13.2%	27.7%	-3.8%	9.3%	-6.2%
2025	1.9%	17.8%	11.4%	9.2%	12.6%	19.8%	41.6%	1.7%	27.6%	1.2%
2030	8.4%	23.7%	15.3%	13.0%	16.8%	26.4%	55.5%	7.3%	52.0%	8.5%
2035	13.5%	29.7%	19.1%	16.9%	21.0%	33.0%	67.5%	12.8%	75.9%	15.8%
2040	19.6%	35.6%	22.9%	25.4%	25.3%	39.7%	79.6%	18.4%	93.3%	23.2%

The population projections also include the number of seniors (65+) which can be expressed in relative terms as a percentage of the total population. Although not exactly the same as the percentage of households with seniors (65+), the growth in the percentage of seniors in the population can be assumed to closely approximate the growth in the percent of households with seniors.

**Table 10 Historic and Projected Senior (65+) Population as a Percentage of Total Population by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
1990	15.4%	14.7%	12.9%	12.0%	13.3%	12.7%	14.6%	14.9%	12.6%	11.0%
2000	16.6%	14.1%	12.5%	13.3%	12.9%	12.7%	16.2%	16.1%	12.6%	10.8%
2010	17.4%	16.1%	16.0%	15.9%	16.2%	13.1%	21.5%	18.6%	15.5%	13.8%
2015	19.5%	18.4%	18.4%	18.4%	18.6%	15.2%	23.6%	21.4%	17.4%	15.5%
2020	21.5%	19.8%	19.9%	19.5%	19.6%	16.9%	23.5%	23.3%	18.5%	17.3%
2025	23.0%	20.9%	20.8%	20.6%	20.4%	18.5%	23.0%	24.4%	19.1%	18.9%
2030	24.0%	21.8%	21.2%	21.3%	21.0%	19.7%	21.9%	24.8%	19.4%	19.8%
2035	24.0%	22.1%	21.4%	21.7%	21.2%	20.2%	20.9%	24.4%	19.4%	19.8%
2040	23.4%	21.9%	20.7%	21.8%	21.0%	20.4%	19.9%	23.4%	19.2%	19.0%

The historic and projected senior population as a percentage of the total population is presented above in Table 10, while the growth in the percentage of seniors is presented below in Table 11. In general in coming years seniors are expected to grow as a portion of the population with the aging of the baby boomers, peaking around 2035. The one exception is

Loudon County, where in-migration of younger people to support a strong demand for labor is expected to hold the percentage of seniors relatively constant.

**Table 11 Future Growth in Seniors as a Share of the Population**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union
2015	12.4%	14.5%	15.2%	16.0%	14.8%	16.3%	10.0%	15.1%	12.7%	12.5%
2020	23.4%	23.4%	24.2%	23.0%	21.1%	29.5%	9.6%	25.3%	19.6%	25.4%
2025	32.5%	30.1%	30.0%	30.0%	26.0%	41.5%	7.2%	31.6%	23.4%	37.1%
2030	38.0%	35.5%	32.5%	34.5%	29.8%	50.5%	2.1%	33.6%	25.5%	44.0%
2035	38.1%	37.3%	33.8%	36.9%	30.7%	54.3%	-2.7%	31.5%	25.1%	43.8%
2040	34.5%	36.5%	29.5%	37.4%	29.7%	55.8%	-7.3%	26.3%	24.2%	37.9%

## Employment

The U.S. Department of Commerce, Bureau of Economic Analysis (BEA), provides annual estimates of employment by industry sector. Unlike employment estimates from the Bureau of Labor Statistics, which only include wage and salary employment, BEA employment estimates include farmers, government workers and the self-employed who are not counted in the former. The BEA employment is consistent with the Knoxville regional travel model's definition of employment. Historic employment data was obtained from the BEA for the ten counties for the forty year period from 1970-2010.

This data was used to make multiple forecasts of employment in each county by each industry sector based on linear regression over the whole and/or a subset of the data, non-linear regression, the twenty-year, forty-year or other average historic growth rates, and the highest and lowest (generally ten year) growth rates observed within the past forty years.

Proprietary employment forecasts from Woods & Poole for the ten counties were also obtained. Because of significant variations in the Woods & Poole forecasts in recent years, both the 2011 and the 2012 series forecasts were considered.

The various candidate forecasts produced by BLA were then compared against each other and Woods & Poole and professional judgment used to select the best forecast. In some cases, the chosen forecast was a compromise or weighted average between two or more of the basic forecasts.

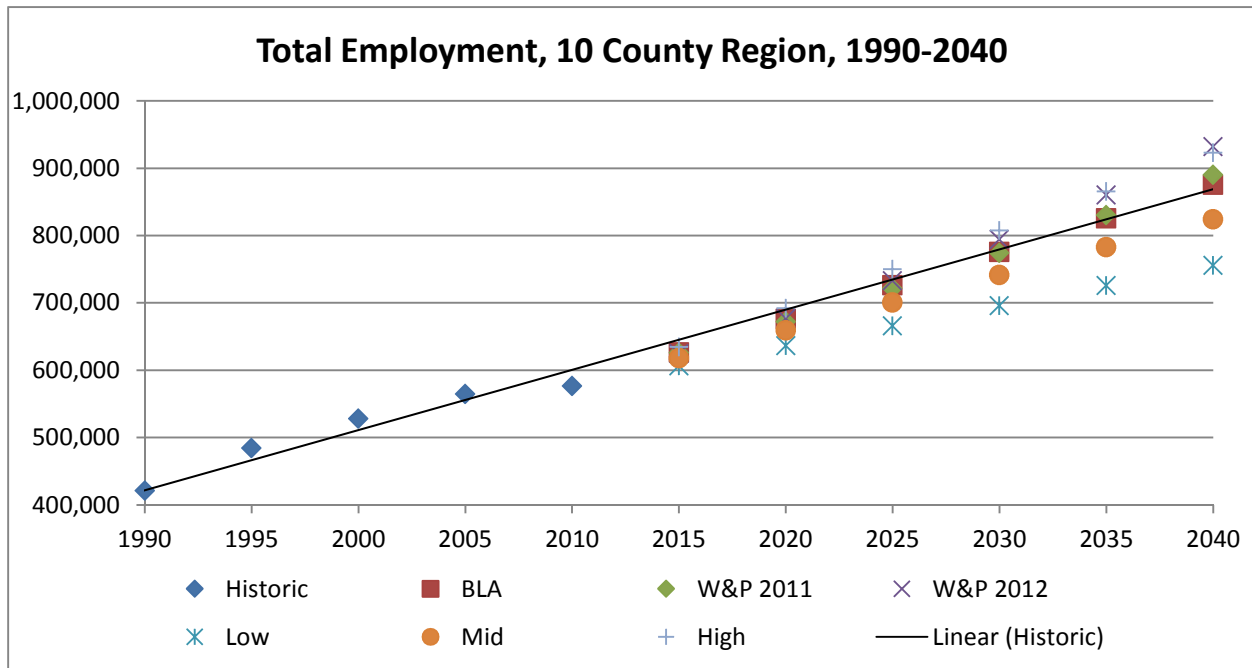
The employment in each of the model's four industry groups (basic, industrial, retail and services) was combined to produce a forecast of the total employment in each county. This forecast was compared to independent forecasts of total employment (from Woods & Poole and by the various methods described above) as a further reasonableness check, and in some cases the industry level forecasts were revised.

## Knoxville Regional Travel Model Update 2012

**Table 12 Historic and Projected Total Employment by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union	Region
1990	41,221	34,590	6,054	35,545	14,834	218,868	12,903	24,032	29,364	3,837	421,248
1995	50,381	41,154	7,089	38,390	16,595	245,034	14,800	26,524	39,969	4,596	484,532
2000	50,603	50,628	7,533	43,067	18,576	269,737	15,709	23,632	44,506	4,625	528,616
2005	52,140	58,451	7,140	42,387	18,165	291,699	18,408	21,778	49,858	4,822	564,848
2010	52,285	59,288	6,764	38,079	18,926	303,682	19,191	22,602	51,322	4,848	576,987
2015	56,150	63,560	7,230	40,326	20,247	330,996	21,167	24,083	57,679	5,356	626,795
2020	60,016	67,831	7,696	42,572	21,569	358,310	23,143	25,565	64,036	5,865	676,603
2025	63,881	72,103	8,163	44,819	22,890	385,623	25,119	27,046	70,393	6,373	726,410
2030	67,747	76,374	8,629	47,066	24,211	412,937	27,095	28,528	76,750	6,881	776,218
2035	71,612	80,646	9,095	49,312	25,532	440,251	29,071	30,009	83,108	7,389	826,026
2040	75,477	84,918	9,561	51,559	26,854	467,565	31,047	31,491	89,465	7,898	875,834

Summarized historic and viable and chosen projections of employment for each county are found in Appendix C. The resulting projections are displayed together with the historic data for in five year increments in Table 12. The projected regional total employment resulting from the chosen county forecasts was also plotted against simple historic rate based forecasts as an independent reasonableness check (displayed in Figure 10).



**Figure 10 Eastern Tennessee 10 County Region Total Employment, 1990-2040**

### Unemployment

The consistency of the employment and population forecasts was checked by estimating the implied unemployment rate for each county in 2040. Unemployment is the difference between the labor force and the wage and salary employment. Since the employment forecasts are for

total employment, the wage and salary portion which are eligible for unemployment insurance must be estimated, holding out proprietorships, certain government workers, etc. Given the uncertainty in this, the 2040 unemployment rates should be considered only rough estimates for the purpose of reasonableness checking.

**Table 13 Historic and Implied 2040 Unemployment Rates by County**

	Anderson	Blount	Grainger	Hamblen	Jefferson	Knox	Loudon	Roane	Sevier	Union	Region
1990	5.0	5.4	6.8	6.5	7.6	4.3	5.9	8.6	9.0	5.5	<b>5.0</b>
1995	4.0	5.4	6.8	7.1	7.3	3.5	4.1	5.9	8.9	4.7	<b>4.4</b>
2000	4.2	3.6	4.6	4.1	4.4	3.2	3.6	4.4	5.0	3.9	<b>3.3</b>
2005	5.2	4.7	6.0	5.8	5.9	4.2	4.7	5.8	6.1	5.6	<b>4.5</b>
2010	9.0	8.4	12.8	10.8	12.0	7.6	8.3	8.0	10.3	9.3	<b>8.2</b>
2040	6.6	6.7	6.3	3.2	7.8	3.7	5.0	6.5	5.8	5.0	<b>4.7</b>

The estimated unemployment rates ranged from 3.2% to 7.8% with a regional average of 4.7% unemployment. For the region as a whole and most counties, this represented a level of unemployment that was greater than in 2000 when the economy was booming and less than in 2010 when the economy was still in the midst of the great recession. These estimated unemployment rates suggest reasonable consistency between the employment forecasts and the labor force forecasts and therefore also with the population forecasts which derive from them.

### **Employment by Industry and by Year**

As was noted above, employment was forecast by four industry groups (Basic, Industrial, Retail and Service) and checked against total employment. These employment totals by industry are required for the travel demand model. Since the travel demand model’s forecast years vary somewhat from the years originally produced by this process due to the timing of the plan documents and due to some definitional details for the industry groups, the TPO developed the breakout of employment by industry by year for the years required for their plan development displayed in Table 14. This distribution is a reasonable adaptation of the direct results of the forecasting process for use in the model, given the nuances of the definitions of the industry groups in the travel model.

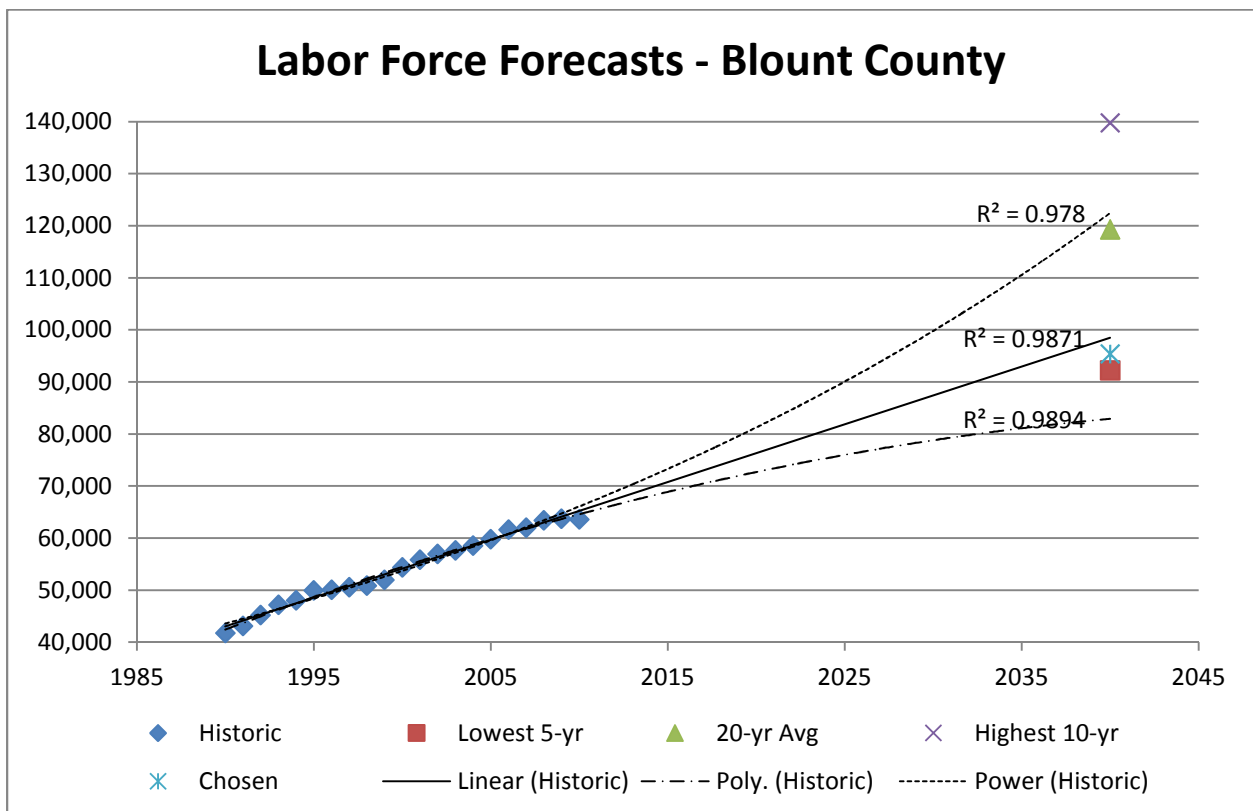
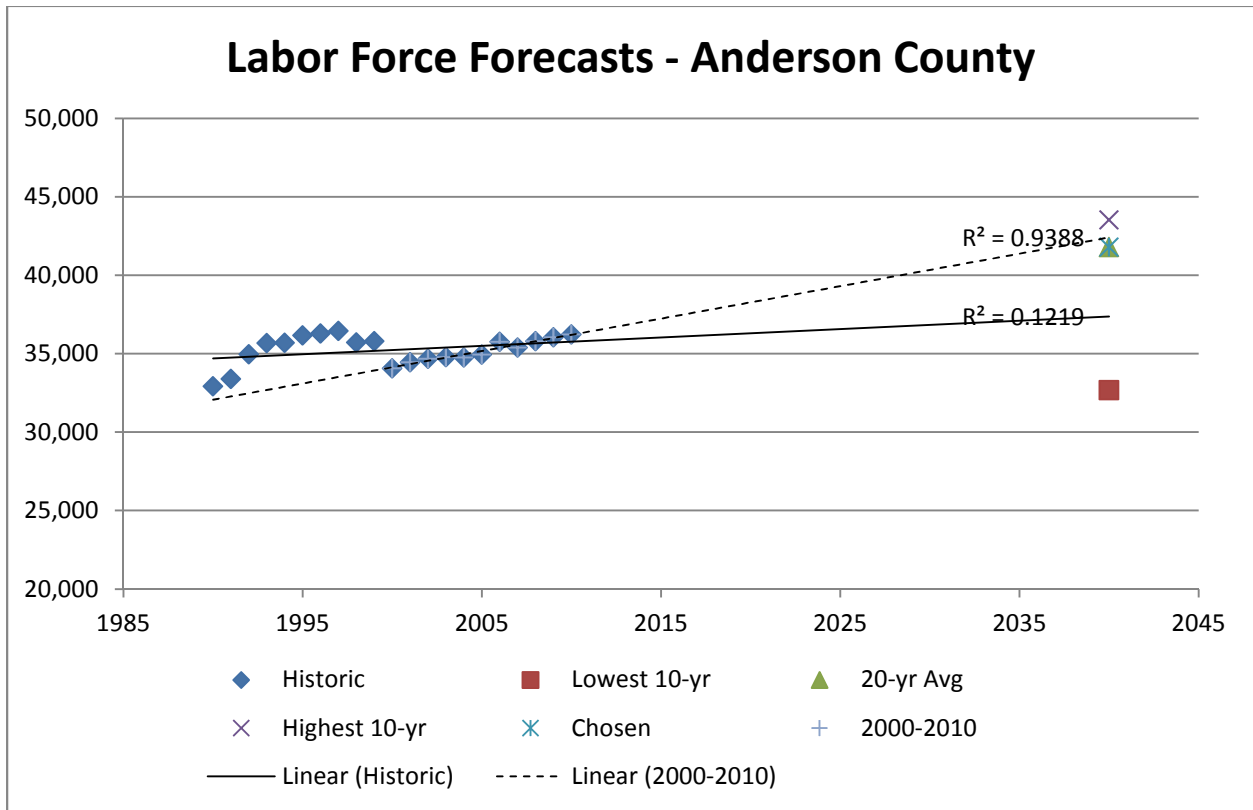
**Table 14 Employment by County by Industry by Year**

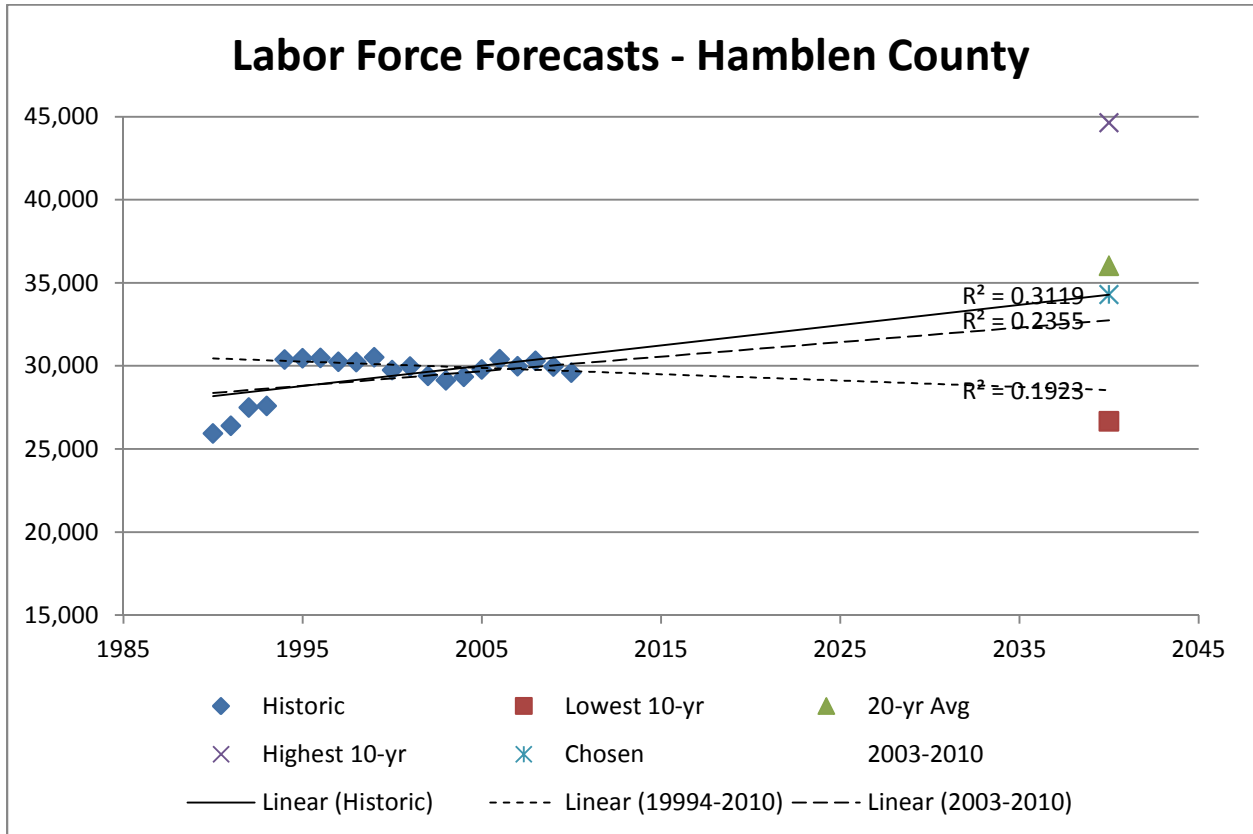
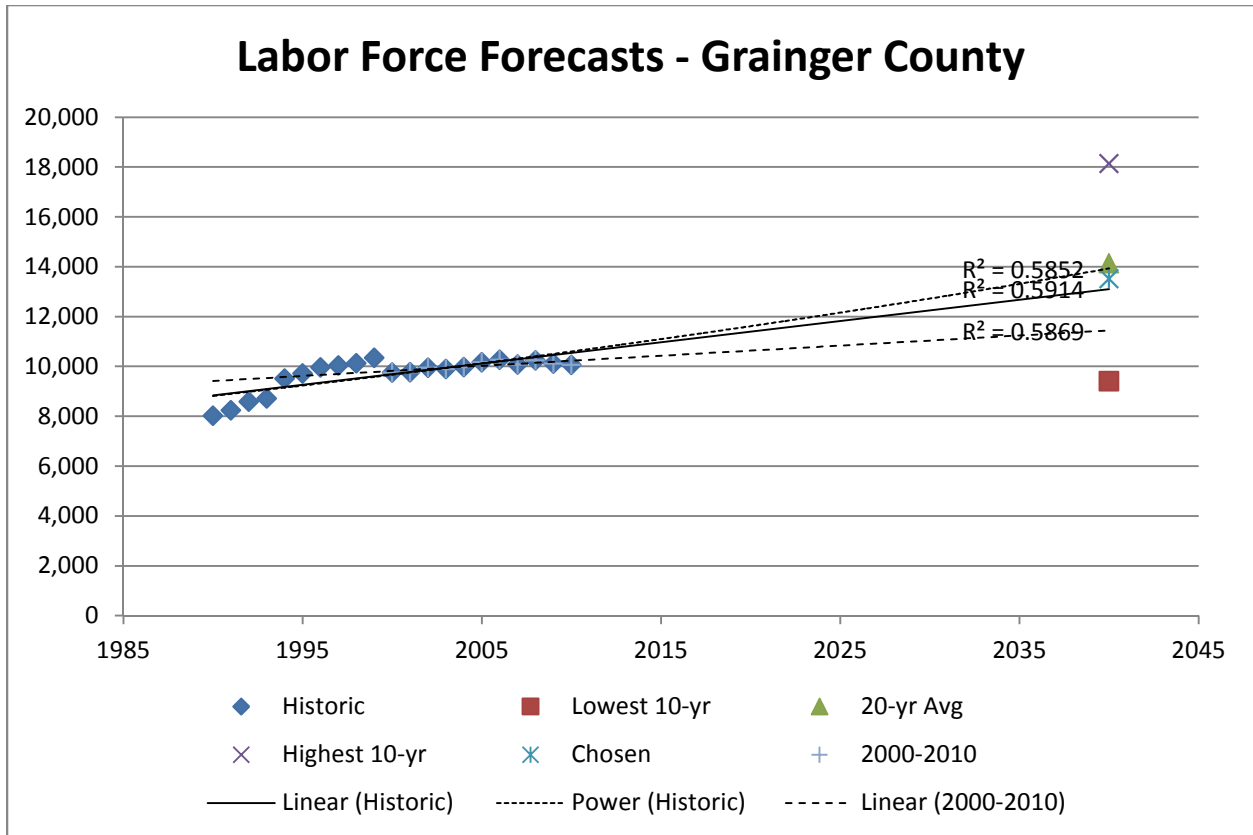
County	Sector	2010	2014	2024	2034	2040
Anderson	Basic	5,612	5,933	6,987	8,068	8,717
Anderson	Industrial	9,861	10,158	10,565	10,831	10,940
Anderson	Retail	8,186	8,639	9,859	11,164	11,981
Anderson	Service	28,908	30,420	35,492	40,708	43,838
Anderson_Total		52,567	55,150	62,903	70,772	75,477

## ***Knoxville Regional Travel Model Update 2012***

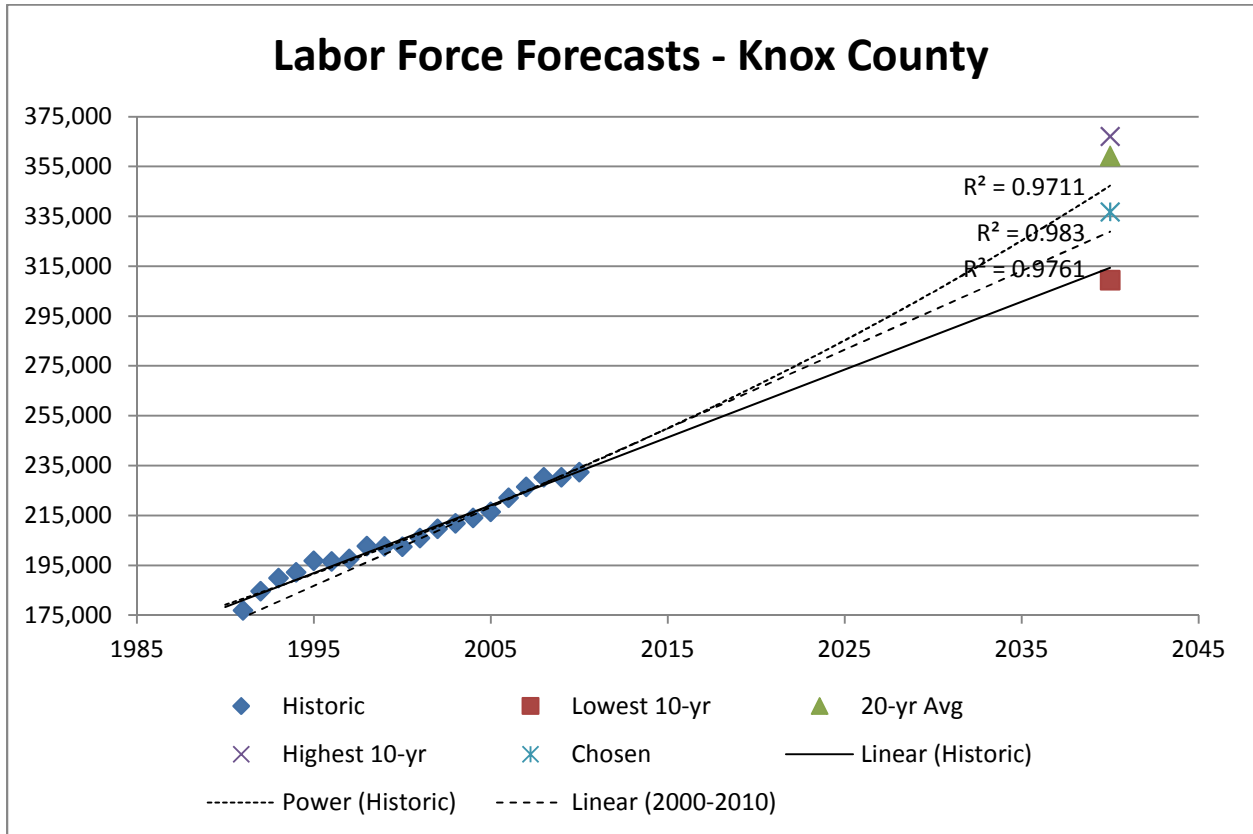
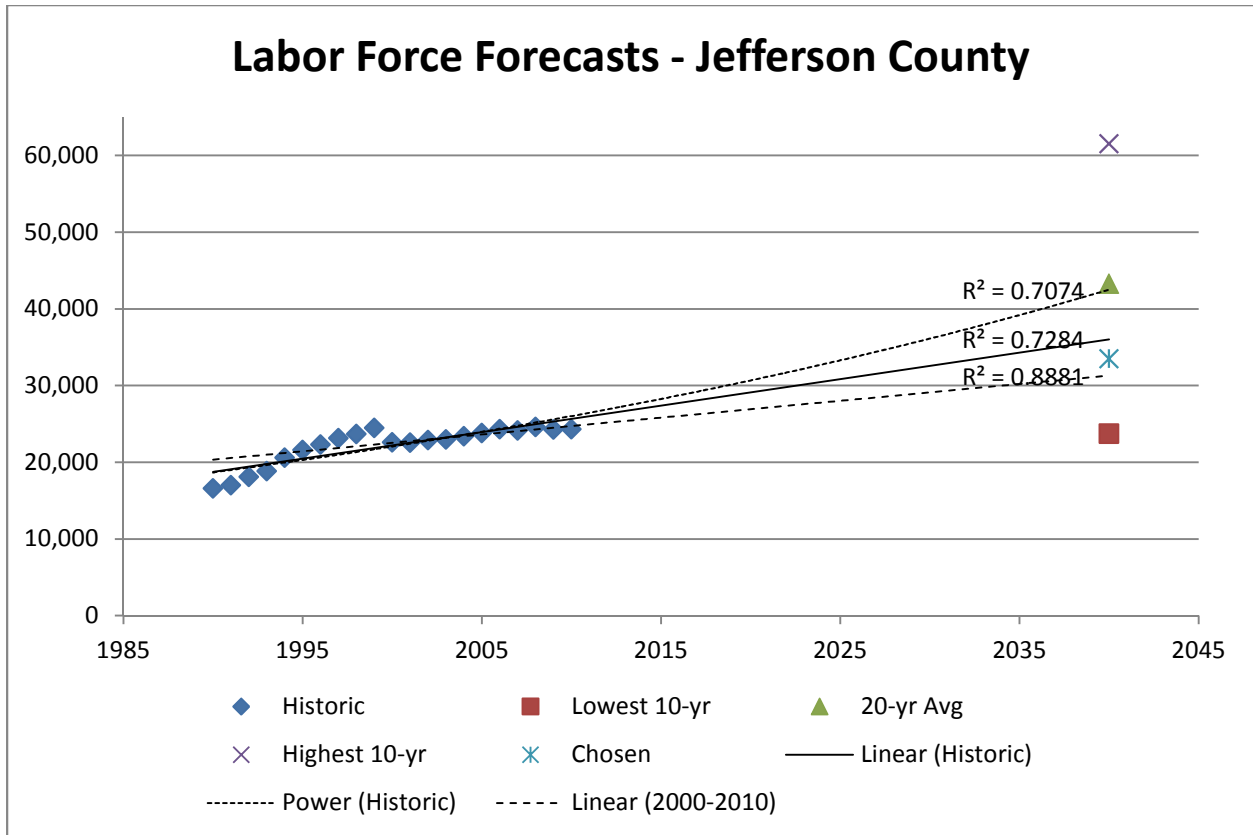
<b>County</b>	<b>Sector</b>	<b>2010</b>	<b>2014</b>	<b>2024</b>	<b>2034</b>	<b>2040</b>
Blount	Basic	7,357	7,357	7,451	7,770	8,002
Blount	Industrial	10,452	10,593	11,883	12,861	13,632
Blount	Retail	11,365	11,839	13,758	15,759	16,959
Blount	Service	30,629	31,988	37,367	42,965	46,324
<b>Blount_Total</b>		<b>59,803</b>	<b>61,777</b>	<b>70,458</b>	<b>79,354</b>	<b>84,918</b>
Grainger	Basic	1,964	1,978	2,052	2,191	2,266
Grainger	Industrial	1,324	1,325	1,412	1,508	1,566
Grainger	Retail	647	679	798	922	997
Grainger	Service	2,981	3,145	3,743	4,361	4,732
<b>Grainger_Total</b>		<b>6,916</b>	<b>7,126</b>	<b>8,005</b>	<b>8,983</b>	<b>9,561</b>
Hamblen	Basic	2,805	2,805	2,805	2,805	2,805
Hamblen	Industrial	11,888	12,310	12,944	14,608	15,606
Hamblen	Retail	6,703	6,893	7,177	8,029	8,540
Hamblen	Service	17,092	18,105	19,625	22,740	24,608
<b>Hamblen_Total</b>		<b>38,488</b>	<b>40,113</b>	<b>42,550</b>	<b>48,181</b>	<b>51,559</b>
Jefferson	Basic	2,941	2,941	2,941	2,941	2,941
Jefferson	Industrial	3,651	3,748	3,893	4,234	4,439
Jefferson	Retail	3,139	3,151	3,550	3,989	4,253
Jefferson	Service	9,603	9,934	11,890	13,972	15,222
<b>Jefferson_Total</b>		<b>19,334</b>	<b>19,775</b>	<b>22,274</b>	<b>25,136</b>	<b>26,854</b>
Knox	Basic	20,933	21,012	21,131	21,537	21,781
Knox	Industrial	37,656	39,066	43,792	48,652	51,568
Knox	Retail	61,220	64,606	75,026	85,662	92,044
Knox	Service	185,579	198,930	238,233	278,195	302,171
<b>Knox_Total</b>		<b>305,388</b>	<b>323,614</b>	<b>378,182</b>	<b>434,046</b>	<b>467,565</b>
Loudon	Basic	2,672	2,672	2,672	2,672	2,679
Loudon	Industrial	4,407	4,498	5,149	5,846	6,264
Loudon	Retail	3,650	3,814	4,573	5,371	5,849
Loudon	Service	8,651	9,124	11,361	14,234	16,254
<b>Loudon_Total</b>		<b>19,380</b>	<b>20,108</b>	<b>23,755</b>	<b>28,122</b>	<b>31,047</b>
Roane	Basic	1,522	1,522	1,522	1,522	1,522
Roane	Industrial	2,044	2,067	2,100	2,191	2,246
Roane	Retail	3,345	3,374	3,742	4,215	4,536
Roane	Service	15,589	16,277	18,876	21,571	23,187
<b>Roane_Total</b>		<b>22,500</b>	<b>23,240</b>	<b>26,241</b>	<b>29,499</b>	<b>31,491</b>
Sevier	Basic	4,696	4,804	5,425	6,154	6,630
Sevier	Industrial	1,863	2,043	2,464	2,882	3,133
Sevier	Retail	21,376	23,802	28,466	33,395	36,550
Sevier	Service	23,461	25,664	31,586	38,499	43,152
<b>Sevier_Total</b>		<b>51,396</b>	<b>56,312</b>	<b>67,941</b>	<b>80,930</b>	<b>89,465</b>
Union	Basic	1,059	1,088	1,221	1,362	1,447
Union	Industrial	994	1,055	1,265	1,481	1,611
Union	Retail	596	623	727	834	898
Union	Service	2,275	2,448	3,013	3,594	3,884
<b>Union_Total</b>		<b>4,924</b>	<b>5,214</b>	<b>6,226</b>	<b>7,271</b>	<b>7,840</b>

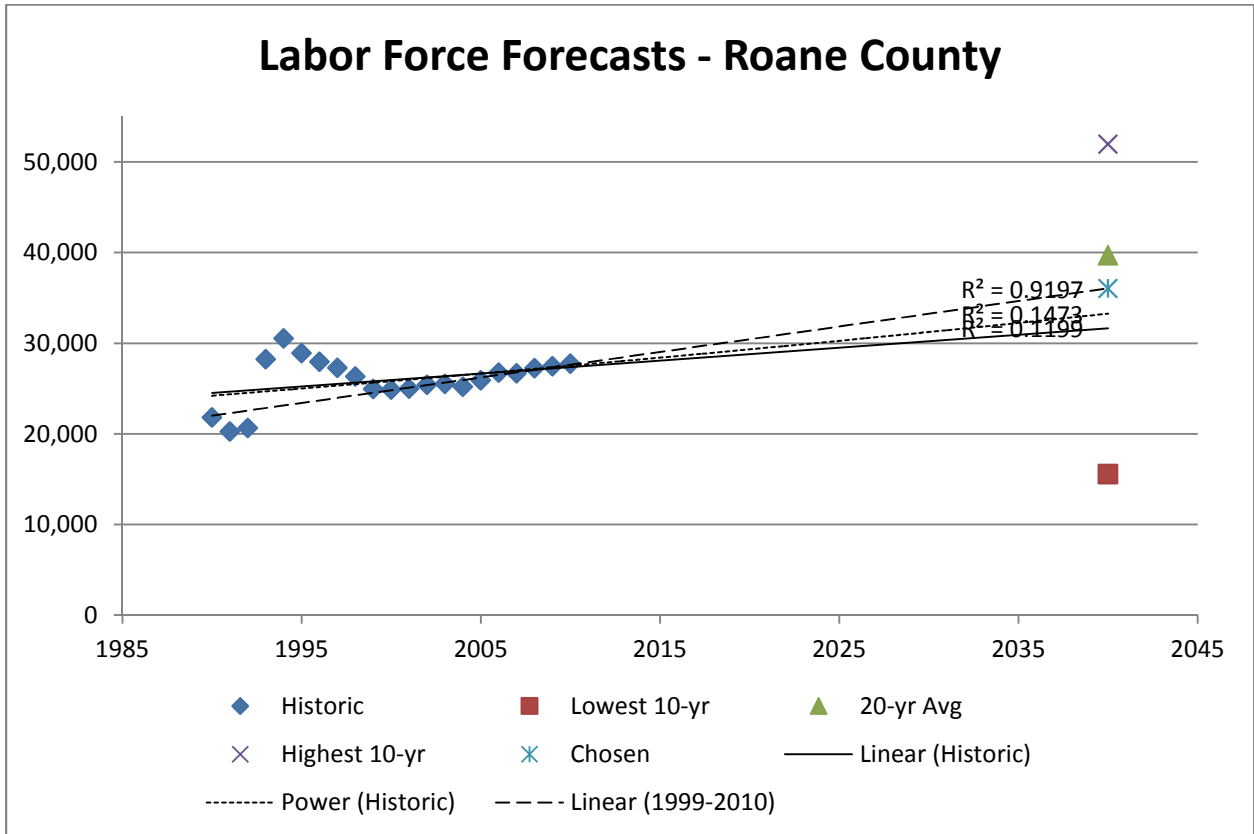
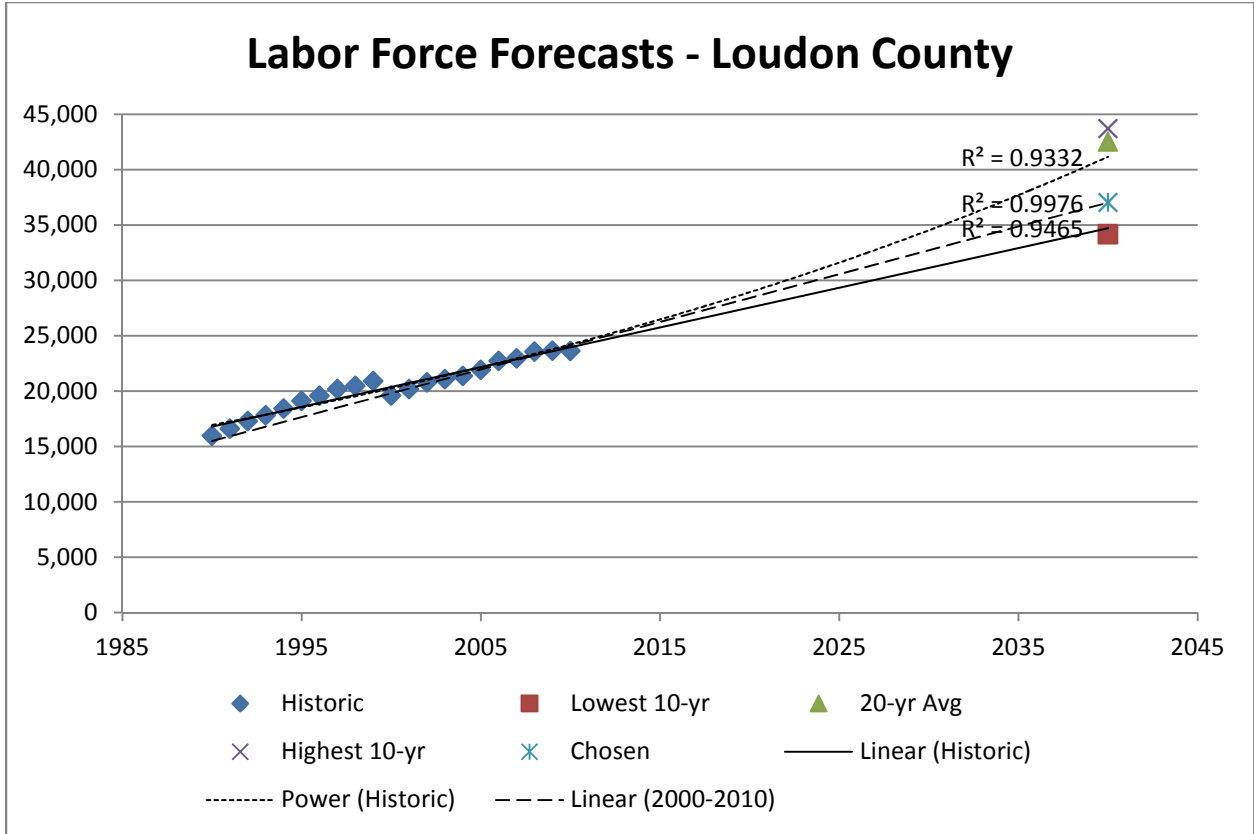
Appendix A: Labor Force Projections by County

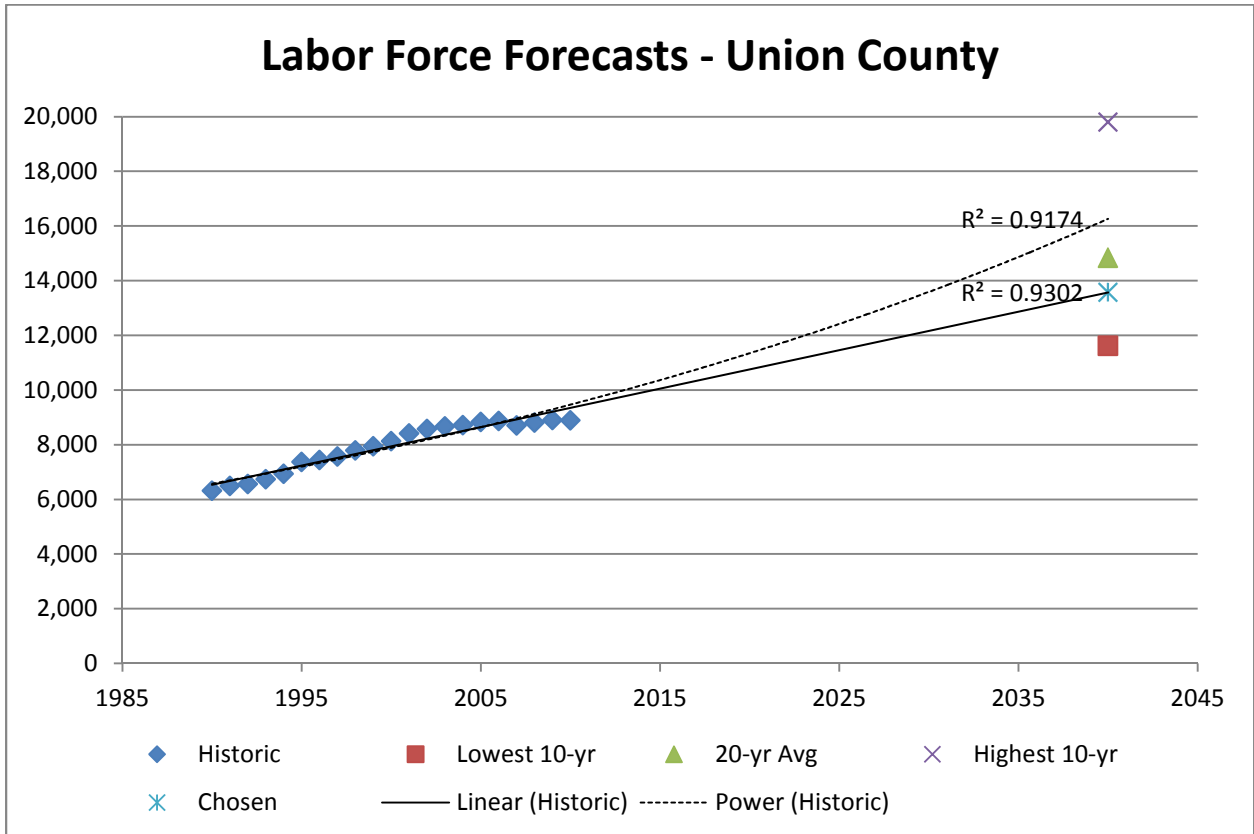
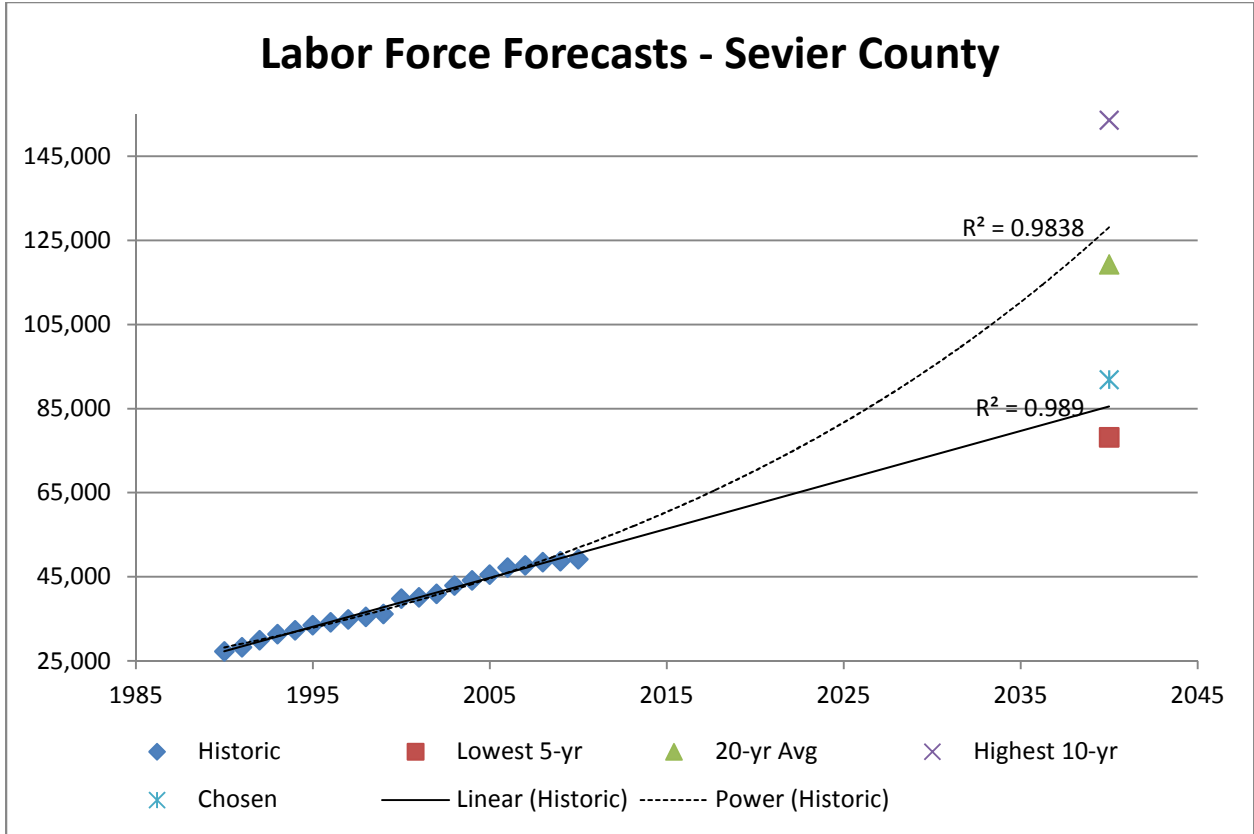




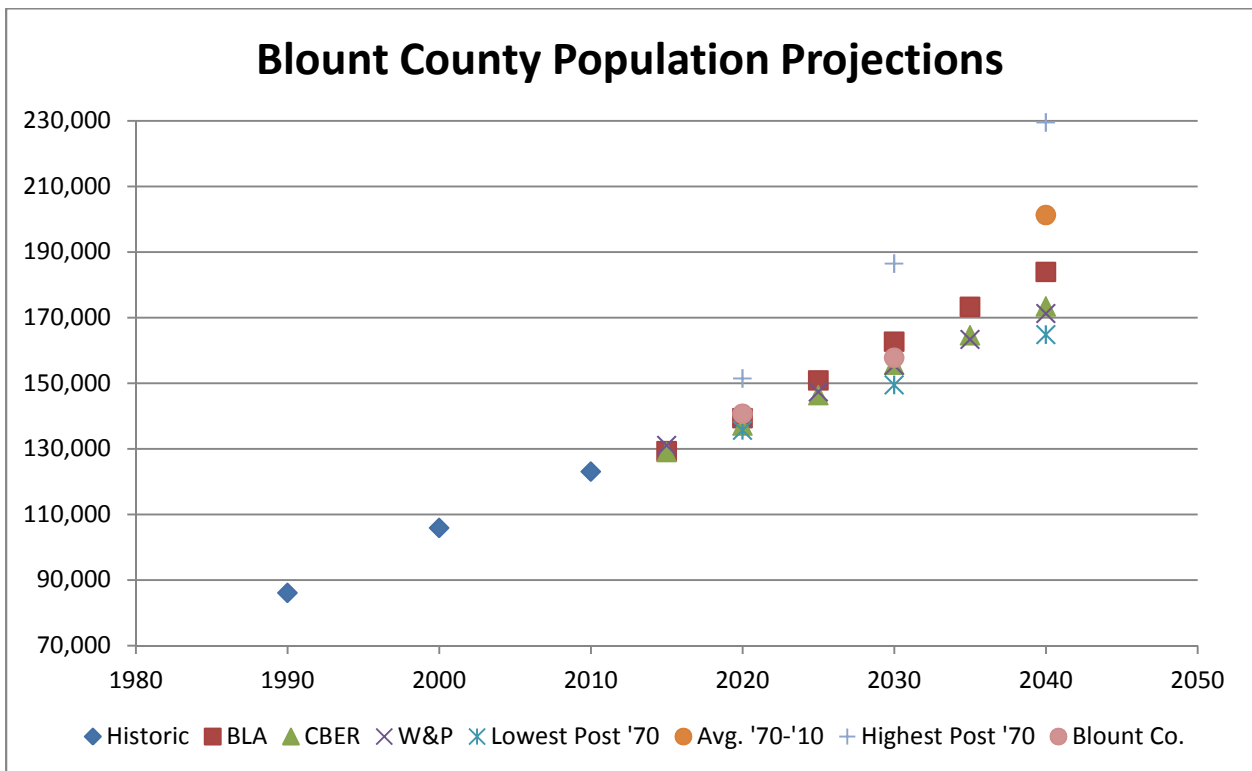
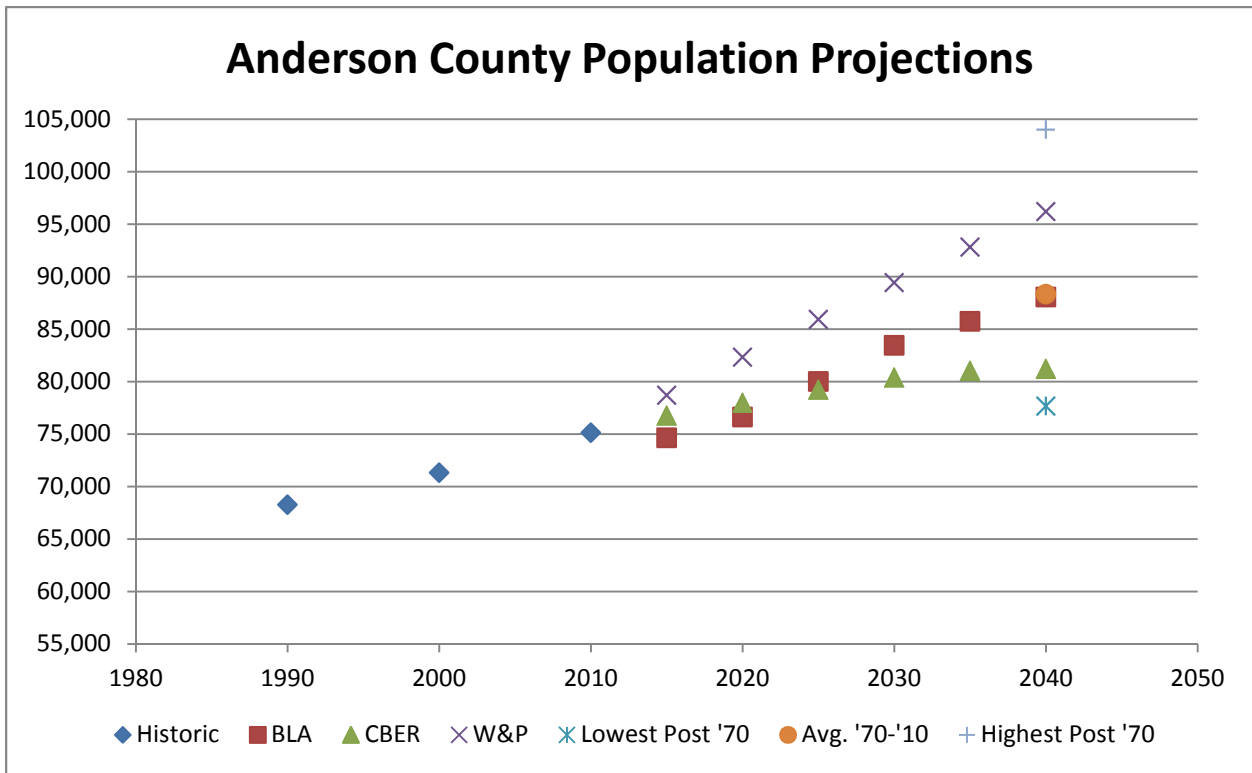


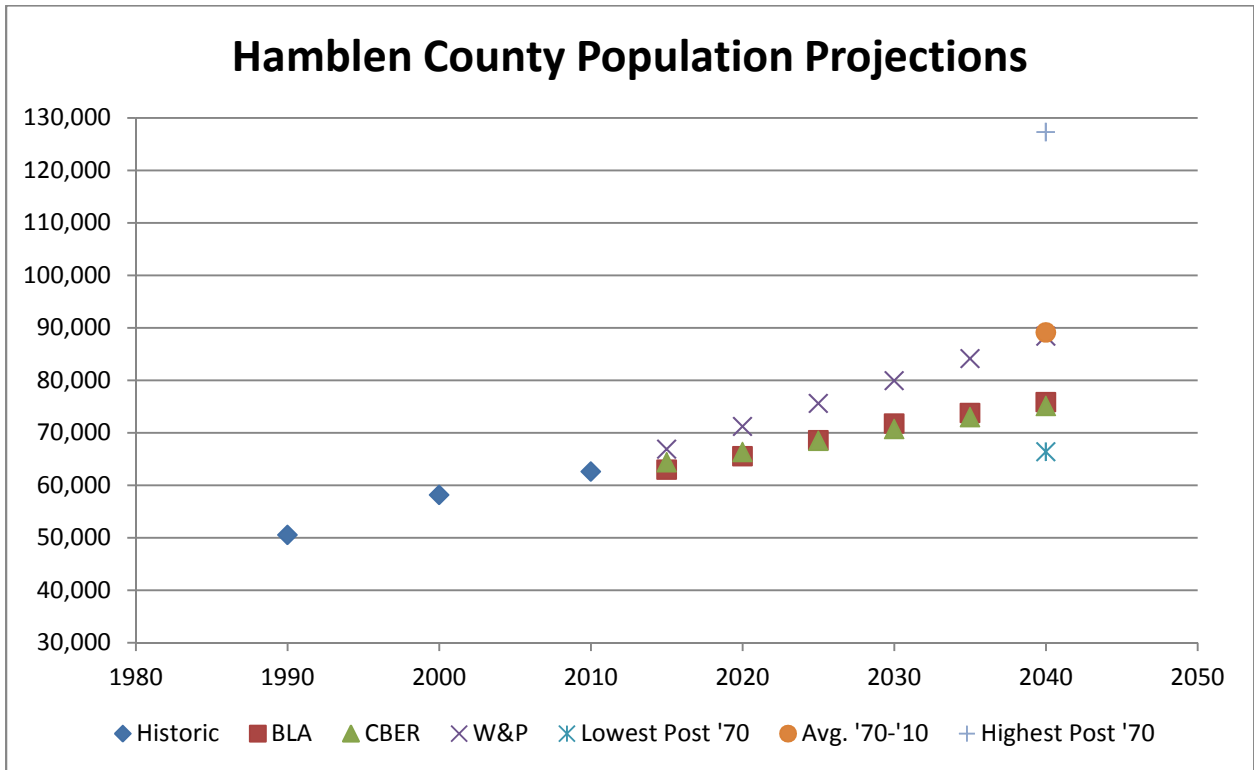
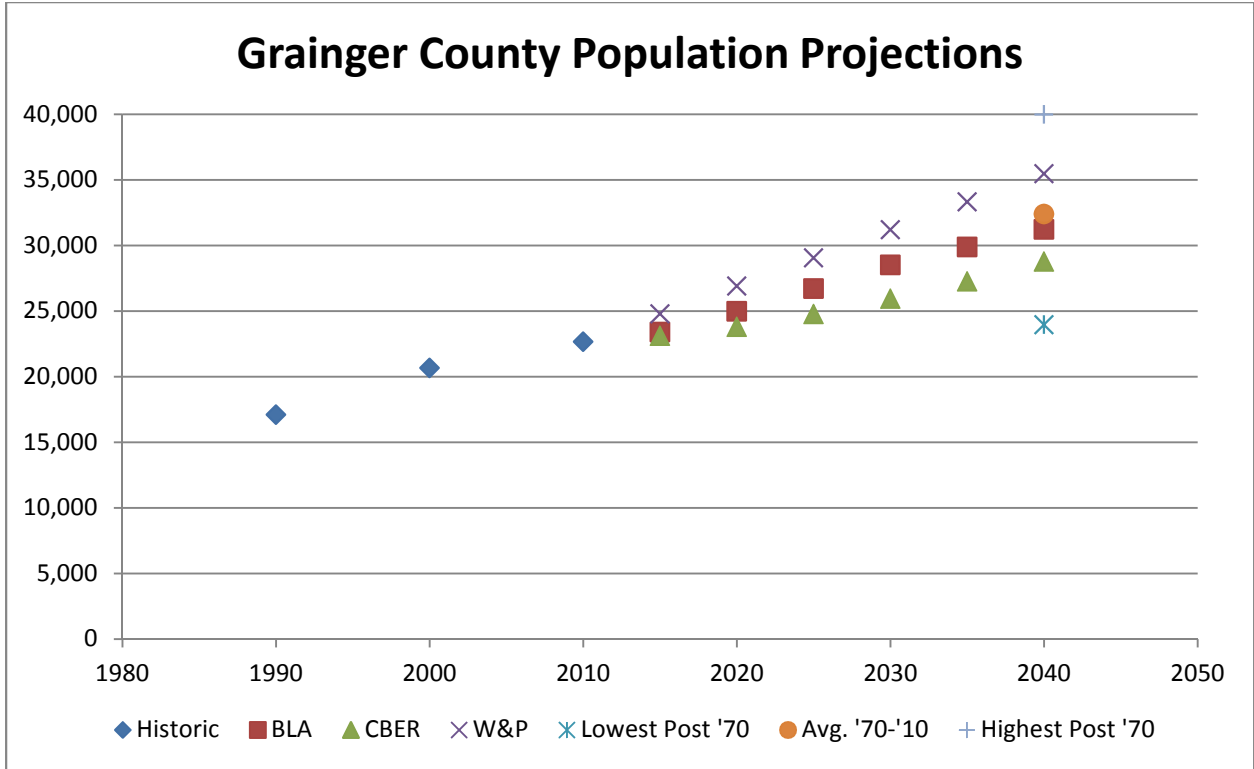


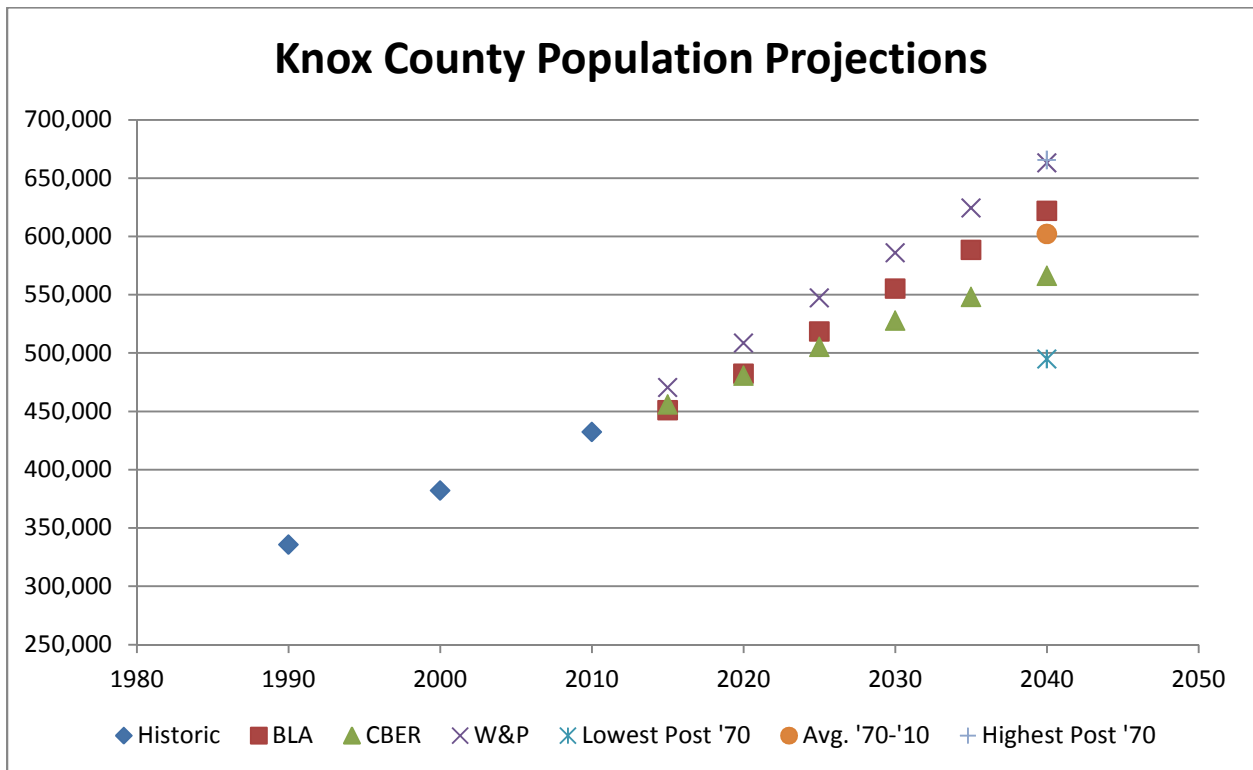
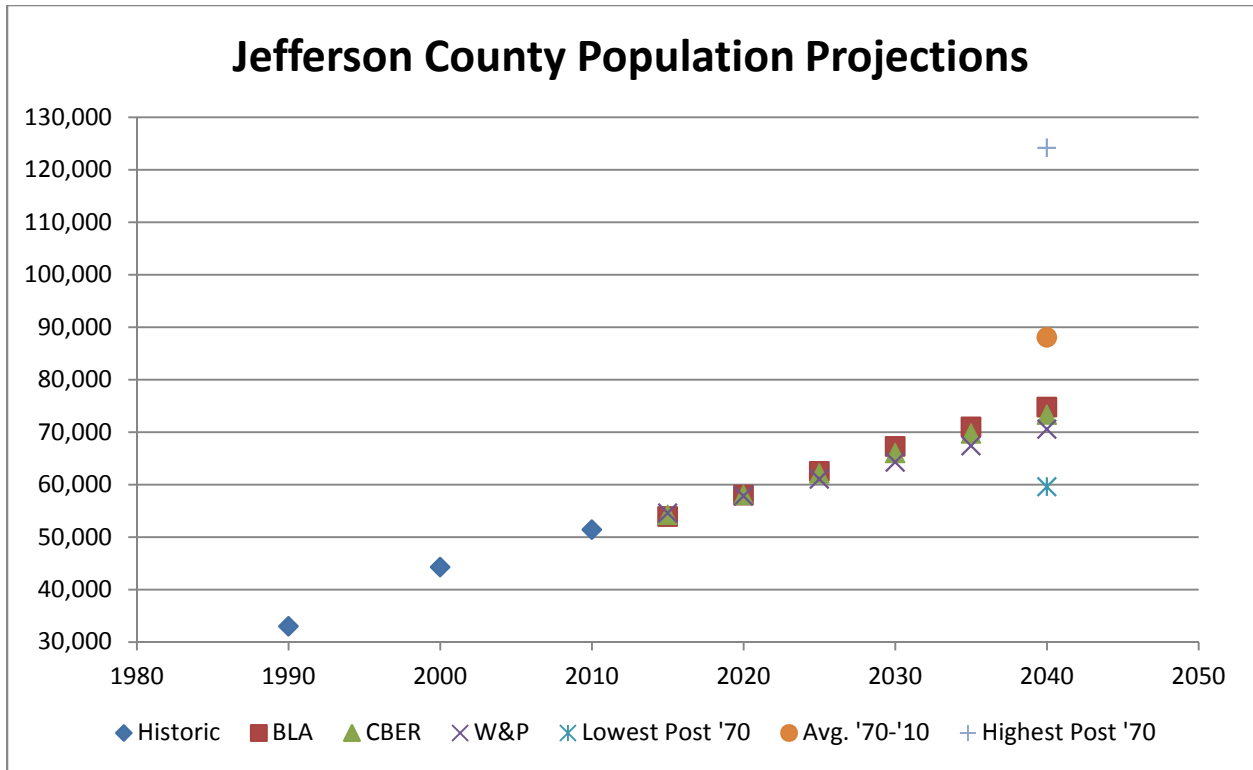


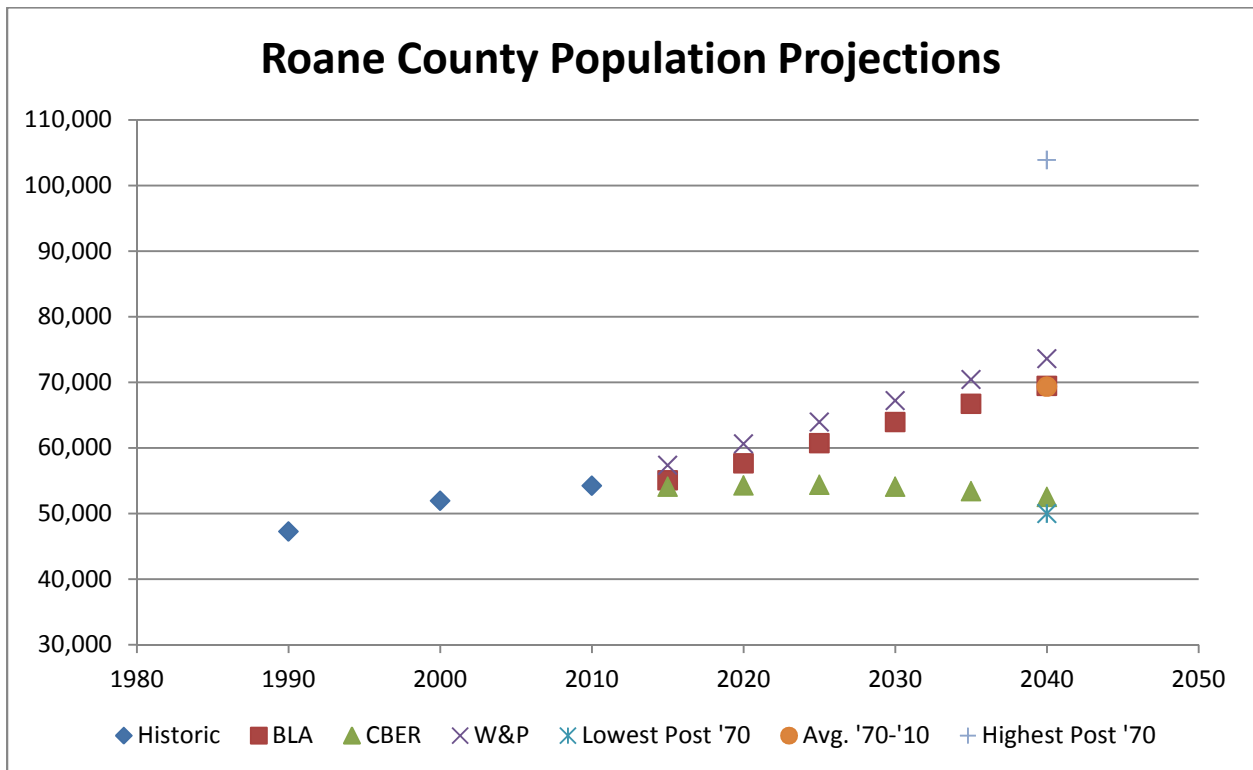
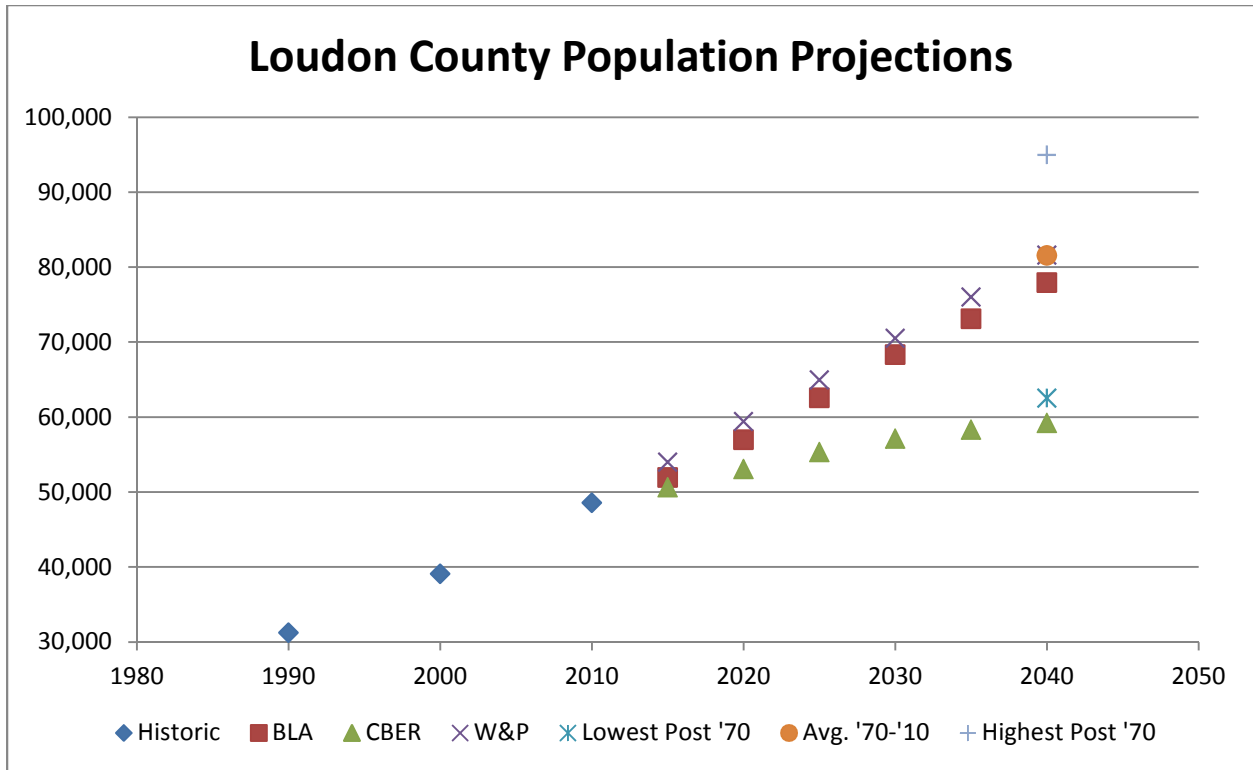


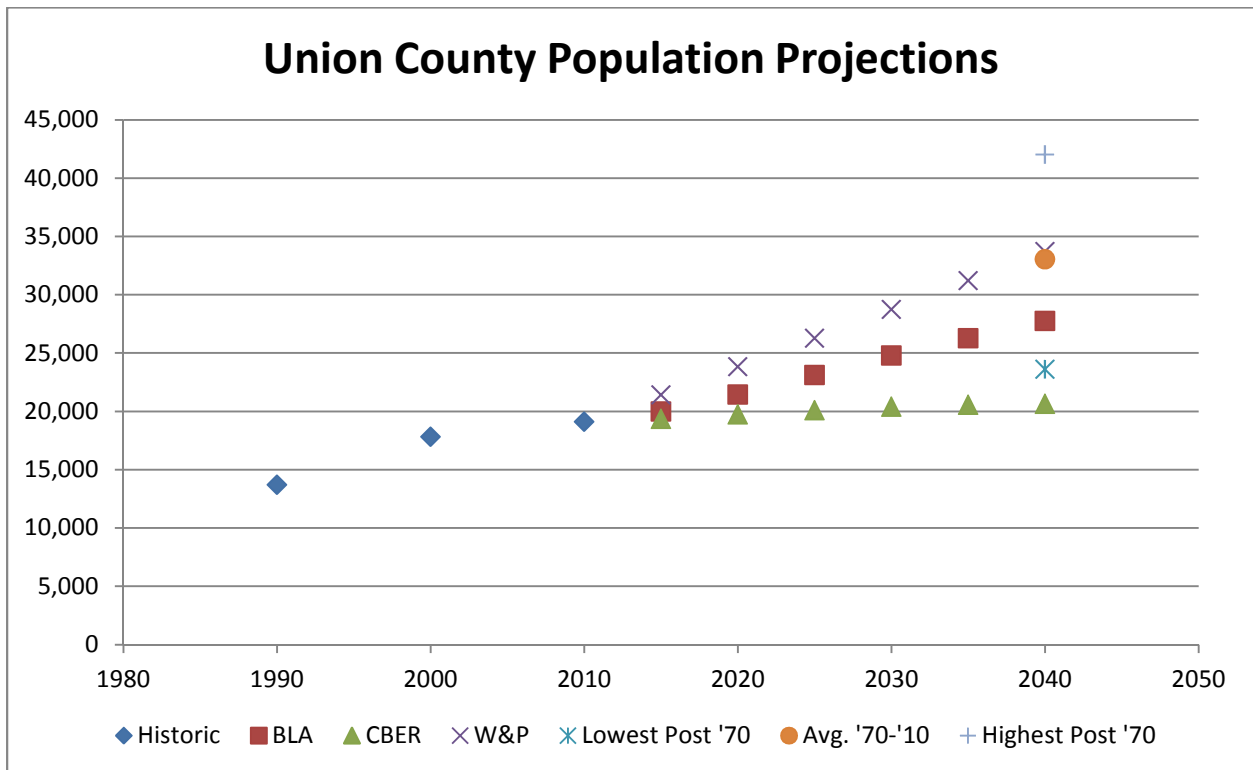
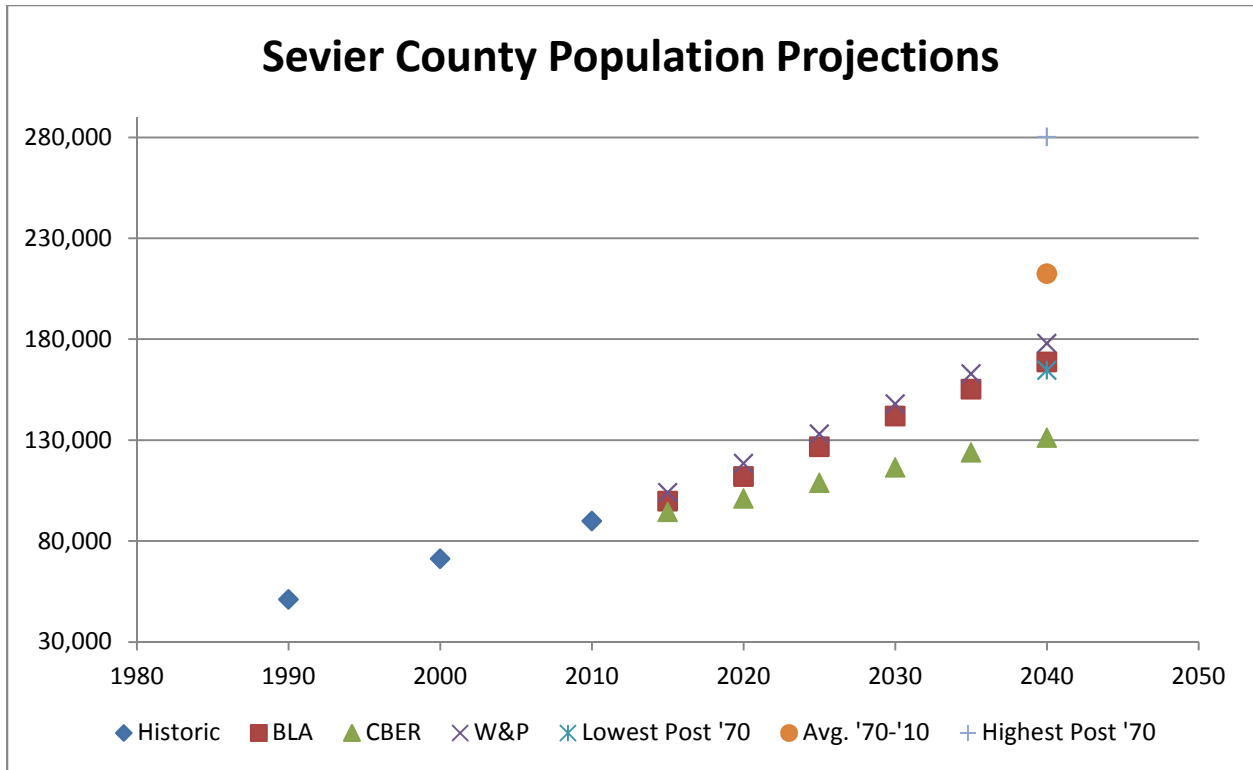
**Appendix B: Population Projections by County**













**Appendix C: Employment Forecasts by County**

